USAELRDL Technical Report 2306

PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS

(SPRF #1)

W. Schlosser
C. P. Lascaro
J. Key

Scale-1

September 1962

UNITED STATES ARMY
ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, N.J.

$4.60

U. S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY

FORT MONMOUTH, NEW JERSEY

September 1962

USAELRDL Technical Report 2306 has been prepared under the supervision of the Director, Electronic Components Department, and is published for the information and guidance of all concerned. Suggestions or criticisms relative to the form, content, purpose, or use of this publication should be referred to the Commanding Officer, U. S. Army Electronics Research and Development Laboratory, Attn: Chief, Reliability and Electronic Parts Branch, Electronic Parts and Materials Division, Fort Monmouth, New Jersey.

J. M. KIMBROUGH, JR
Colonel, Signal Corps
Commanding

OFFICIAL:
HOWARD W. KILLAM
Major, SigC
Adjutant

DISTRIBUTION:
Special

CONTENTS

CONTENTS (Contd)

TABLES

FIGURES

PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS (SPRF#1)

INTRODUCTION

For the past several years, experiments have been conducted on the effects of high-intensity nuclear radiation pulses on electronic parts and materials including resistors, capacitors, semiconductors, magnetic cores, and coaxial cables. Many of the results were found to be spurious and inconsistent, and a few measurements appeared to indicate that some of this erratic behavior may have been attributable to the coaxial cables used to connect the exposed parts to the measuring instrumentation. Therefore, the experiment described in this report was primarily a detailed study of pulse nuclear radiation effects in cables and was designed to study the effect of variations in physical and electrical parameters on the electrical performance characteristics of various cable types. Each test specimen underwent a series of up to eighteen radiation bursts during which the applied voltage was changed. In addition, tests were conducted to determine the radiation susceptibility of resistors and ferrite inductors.

EXPERIMENTAL PROCEDURE

Facility

1. *SPRF* – This experiment was conducted from August 7-11, 1961, at the Sandia Pulse Reactor Facility (SPRF), Albuquerque, New Mexico.[1] The SPRF consists of several buildings arranged as shown in Fig. 1. The reactor is housed in the reactor building, which is a hemispherical dome of poured concrete, and space is provided outside this building for setting up instrumentation trailers for conducting the experiments. The reactor is raised by elevator from a pit for operation and is lowered after each burst. The beam catcher building serves to reduce the radiation level immediately outside the reactor building. The resulting level was still too high, however, to permit the occupied trailer to be set up near the reactor building. It was necessary, therefore, to conduct the experiment with the trailer located approximately 100 feet away from the reactor building. The remaining buildings are used by Sandia Corporation for operation of the facility. Electrical power at 208 volts, 100 amperes, 3 phase, 60 cps is available for operating the trailer laboratories. Patch panels and conduits are available for signal transmission from inside the reactor building to the instrumentation trailers.

2. *SPR* – The Sandia Pulse Reactor (SPR), Fig. 2, is a bare, enriched uranium assembly, based on the design of the Los Alamos Scientific Laboratory's Godiva II. A typical burst has the following characteristics:

   a. 50-microsec width at half maximum pulse height

   b. 3×10^{16} leakage neutrons/burst

   c. 3×10^{20} neutrons/second peak leakage rate

   d. Radiation at the point of closest experimental approach

(1) 2 x 10^{13} neutrons/cm^2, 2 x 10^{17} neutrons/cm^2-sec at peak intensity (E > 1 kev)

(2) 2 to 3 x 10^{13} rads (water) from gammas, 2 to 3 x 10^7 rads/sec from gammas at peak intensity.

Instrumentation

1. *Mobile Laboratory* – The instrumentation used for this experiment was housed in a semitrailer that was prepared for use as a mobile laboratory, Fig. 3. The trailer was provided with oscilloscopes, a cathode follower-amplifier system, power supplies for this system, parameter-measuring circuitry, a pulse generator, a frequency generator, a frequency counter, a time marker generator, and other electronic equipment used in radiation effects measurements. An intercommunication system was installed for use between the laboratory and the reactor building.

2. *Component Instrumentation* – The parts tested were mounted on BNC connectors or directly on coaxial cables and potted. Coaxial cables, Type RG-62A/U, were used to connect the exposed components to their parameter-measuring circuits located, for the most part, in the mobile laboratory. The outputs of the circuits were fed into the oscilloscopes and the trace recorded using Polaroid cameras.

The exceptions to the above case occurred where an ac voltage from the rf signal generator was used for tests on magnetic cores and resistors. The generator and cathode-follower amplifier, which was used for isolation, were located immediately outside the reactor building, and RG-62A/U cable led from there into the trailer laboratory.

A photograph was made of the front panel of each oscilloscope immediately after each shot to provide permanent records of the oscilloscope settings and to minimize errors in extracting data from the film.

3. *Detection Circuits* – The parameter-measuring, or detection, circuits are shown in Fig. 4. Their purpose is to convert a change in an electrical parameter such as resistance, leakage current, and inductance into a change in voltage output to be shown on the oscilloscopes. In the resistor test series, five circuits, including one with an ac voltage, were utilized in an attempt to determine whether or not the measurements are independent of the type of measuring circuit used.

Figure 4A shows a bridge circuit used to measure changes of resistance in resistors. The bridge arms were each equal in resistance to that of the resistor under test.

Figure 4B shows a series circuit used to measure the change in current in coaxial cables. Resistance values of 1 kohm and 10 kohm were used as R_L to measure the cable current change. This circuit was also used to measure resistance changes.

Figure 4C shows another series circuit, this one being used to measure a voltage change in the resistor under test. Resistors in the order of 100 ohms, 1 kohm, and 10 kohms were tested using values of R_L of 100 ohms, 500 ohms, and 10 kohms in the circuit.

The circuit of Fig. 4D was used to study the effect of a radiation pulse on the initial permeability of ferrite inductors. A change in permeability caused by the radiation pulse produces a modulation of the amplitude of the voltage V_L from which the magnitude and duration of the change can be determined. Calibration may be accomplished using a variable air capacitor and noting the change in the L-C circuit voltage as a function of the capacitance; the permeability change can then be calculated. To avoid ambiguity in the permeability measurements, the

:E L-C product may be chosen either less or greater than, but not equal to, $\frac{1}{(2\pi f)^2}$ at which resonance occurs. Thus for L-C less than $\frac{1}{(2\pi f)^2}$, an increase in inductance (or permeability) causes an increase in V_L; for L-C greater than $\frac{1}{(2\pi f)^2}$, an increase in inductance causes a decrease in this voltage. Variations were made in the positions of the cores with respect to the reactor; the cores were tested both at the reactor surface and outside the reactor building but with the connecting cable still at the reactor. In addition, some tests were made with shunt resistors connected to the cable end at the reactor and then across the core with the core outside the reactor building. (See Table 1C.)

Measurements of resistance using an ac voltage source were made with the circuit of Fig. 4E. A resistance change in the resistor R_o was measured as a change in the voltage of R_L, the change appearing as an amplitude modulation of this voltage. A cathode follower-amplifier was used for isolation to keep the lead capacity shunting the resistor as low as possible and to transmit the voltage of R_L to the recording instrumentation some 100 feet away. Any voltage change could be converted to a resistance change by means of a predetermined calibration curve. The test circuit was designed for 100-ohm to 500-ohm resistors primarily to measure large resistance increases of the order of 20 to 30 percent observed in low-value resistors in earlier GODIVA experiments, and could not resolve resistance changes less than about 7 percent.

A measuring circuit with balanced impedance to ground* was designed as an attempt to compensate for coaxial cable effects in the determination of the change in resistance of a 100-kohm resistor. The circuit, Figure 4F, consisted of two RG-62A/U type cables taped side by side with a 100-kohm test resistor soldered to the center conductors at one end of the pair and then potted in paraffin. The cable shields were connected and grounded at the measuring circuitry; a test voltage was applied as shown in the figure, and the individual cable signals were recorded during the radiation burst.

Components Exposed – Components exposed to the radiation pulses are listed below:

Component	Type	Composition
Coaxial Cable	RG-81/U	MgO Dielectric
	RG-62A/U	Air-Polyethylene Dielectric
	RG-59B/U	Solid Polyethylene Dielectric
Twisted Pair	Line Cord	
Resistor	100Ω, ½w, 1%	Carbon film
	500Ω, ½w, 1%	Carbon film
	1kΩ, ½w, 1%	Carbon film
	10kΩ, ½w, 1%	Carbon film
	100kΩ, ½w, 1%	Carbon film
	100Ω, 10w, 5%	Wire wound
Inductor	Ferrite	MnZn
	Ferrite	NiZn

Dosimetry – Dosimetry was provided by both Sandia and USAELRDL. Neutron dose measurements were made with sulphur pellets and U^{238}, Pu^{239}, and Np^{237}.

*This circuit was suggested by Dr. P. R. Arendt, USAELRDL.

Glass rods were provided for gamma dose measurements. The sensors for neutron and gamma measurements were placed on the component stand as close to the exposed components as was physically possible. Table 2 lists, by exposure number, results for each type of dosimeter employed. E

RESULTS AND DISCUSSION

Tabulation of Data – All data were obtained in the form of photographic records, which are graphically reproduced in Figures 7-19. Since, in many cases, experiments were scheduled for maximum utilization of circuits and shots and not in any consecutive order or relation, unrelated curves appear on many photographs. Tables 1A, 1B, and 1C, however, group all pertinent data and contain a coded reference to the figure, photograph, and trace so that further reference can be made by the reader to the original data. The traces are numbered from top to bottom. The tables also include information about the shot number, measuring circuit used, applied voltage, oscilloscope scale factors, and the peak change in current or voltage observed. A scale factor, when given, represents a major division in the reproduced data photographs.

Cables – The test circuits for measuring the cable effects are shown in Figures 4B and 4C. With the cable mounted as shown in Figures 5 and 6, measurements were made of the change in cable current during irradiation with a succession of voltages applied, the voltages ranging from 0 volts through ± 200 volts. For some cable exposures, the battery as open circuited to measure the instrumentation pickup during the burst. In most cases this proved to be negligible. The current pulse was measured as a change in voltage across a measuring resistor of 10 kohms or 1 kohm. All cables except the RG-81/U were 40 feet in length inside the reactor building and connected through a patch panel to the trailer laboratory by 100 feet of RG-62A/U cable. The RG-81/U was 10 feet in length and was connected to a patch panel through approximately 40 feet of RG-62A/U cable. For the tests on straight cables, potted and unpotted, the ends of 40-foot lengths of cable were placed at the reactor, and the cable current change measured as for the cable loops.

The polarity of the current pulses was designated* as follows (Fig. 21): A positive current flow occurs when positive charges move along the off-ground conductor from the unexposed end toward the radiation source. This is the same direction in which a positive current flows if a battery is inserted at the unexposed end so that its positive terminal points toward the radiation source. A return path to ground symbolized by a resistor in Fig. 21 is assumed to be available at least momentarily during the burst. In accordance with accepted conventions, the electron flow direction is the opposite of the positive current flow direction; i.e., during a positive current pulse, electrons are flowing along the center conductor from the radiation source to ground via the measuring resistor. Negative current flow is opposite to that described above.

A discussion of the data can best be made by the consideration of eac ignificant control parameter in the following manner:

1. *Cable Loops* – The loop configuration (Fig. 5) was employed to avoid the exposure of a potting compound close to the reactor; however, the configuration doubled the amount of cable in the reactor building compared to that of the straight configuration.

The observations for the cable loops are tabulated in Table 1A. The same cable samples were used throughout the test series, the voltage on each cable being varied from one exposure to another.

*This designation was proposed by Dr. E. Both, USAELRDL, for adoption as a convention in the presentation of radiation effects data. It presents a complete and consistent description of the current flow in the cable.

E E E

Although there is considerable scatter in the data for each cable type, the peak currents appear to fall along a line whose slope represents an equivalent minimum resistance to which the insulation resistance of the cable falls during exposure. This is illustrated in Fig. 22, which shows straight-line curves. Of the four cables, RG-59B/U was the least affected and showed an equivalent resistance decrease to approximately 500 kohms; the RG-81/U cable decreased in resistance to an order of magnitude lower than the RG-59B/U, possibly due to the interconnecting RG-62A/U cable. The RG-62A/U and the twisted pair showed approximately the same behavior, decreasing to about 100 kohms.

2. *Straight Cables* – Similar measurements on potted and unpotted ends (Fig.6) of RG-62A/U cable showed that the application of an insulating coating inhibits air ionization at the cable end and has a pronounced stabilizing effect on minimizing the peak current response. This is shown in Fig. 23. Peak currents observed for both potted and unpotted straight cables were generally lower than for the looped cables of the same type. The potted-end RG-62A/U cable showed a lower effect than the unpotted-end straight RG-62A/U cable.

3. *Applied Voltage* – There was a general dependence of the cable current upon the magnitude and polarity of the applied voltage although there were, in some cases, cable currents which were inconsistent with the direction of the applied voltage.

The slopes of all curves appear to be directed at the origin, indicating that low voltages should provide low peaked transient currents. Actually, at zero applied voltage, all cables showed a definite current; in the cable loops the direction of this current was always positive and in the straight cables, negative. It is also noteworthy that at low applied voltages some cables currents showed definite polarity reversals during the burst period.

4. *Material* – There is a great difference in the magnitude of the cable currents among the different types of cables studied. The cable which appeared to be most affected was the RG-81/U having the magnesium oxide dielectric. Peak current changes observed here ranged from +3000 μa to −2650 μa. The RG-62A/U cable with air-polyethylene dielectric showed the next highest effects with current peaks ranging from +600 μa to −2500 μa. The twisted pair of wires showed peak currents from +400 μa to −1650 μa. The least affected of the looped cables was the RG-59B/U with the solid polyethylene dielectric in which peak currents of +300 to −380 μa were observed.

5. *Dose* – The discussion of the results assumes that the dosages for each shot were generally equal. While this is not true, any effects that were due to this difference are not apparent in the data. All dosimetry data may be found in Table 2.

6. *History (Prior Exposure)* – The same cables were used throughout the entire experiment. From an examination of Table 1A, it can be seen that no trend toward stabilization is apparent as long as the applied voltage was changed for each succeeding shot. There were, however, several successive shots in which the voltage was not changed. These have been extracted from the Table and are shown as follows:

	Shot No.	Applied Voltage (v)	Peak Current (μa)
RG-62(Loop)	7	−90	[illegible]
	8	−90	−350
	12	−12	50
	13	−12	5
RG-62(Potted) (Straight)	16	−6	60
	17	−6	3
	18	−6	5
	12	−12	7.5
	13	−12	17.5
RG-62(Unpotted) (Straight)	16	−6	95
	17	−6	5
	18	−6	12.5
	7	−200	−500
	8	−200	−340
RG-59(Loop)	14	−6	25
	15	−6	−2.5/3.3

These results seem to indicate that with a constant applied voltage on the cables, the induced peak currents are usually diminished with repeated exposure; although in two cases out of seven, there were slight increases.

Resistors – The resistors were soldered directly to RG-62A/U coaxial cables and potted. Their exposure position was analogous to that of the "straight" cable configuration. Generalized comments are as follows:

1. *100- and 500-ohm Resistors* – These resistors showed no appreciable effect and were independent of the measuring circuit used and the applied circuit voltage. Table 1B shows their apparent percentage changes, assuming that the exposed resistor was the only element in the circuit that underwent any transient change. The maximum resistance changes were of the order of ±0.1% which is one order of magnitude lower than the resistor tolerance value. The 100-ohm wire wound resistor showed a resistance change of about 1%, but in only one out of five exposures. This change, however, was within the tolerance limits for this type of resistor (±5%). It is noteworthy that even though each resistor was soldered to an RG-62A/U coaxial cable, which by itself is capable of pronounced erratic behavior (Table 1A), the change in voltage at the oscilloscope was still very small. Apparently, the voltage drop across the measuring resistor, as a result of the induced cable current, is negligible. The poor resolution of the ac measurements did not allow any changes less than 7% to be detected; within this resolution no changes in resistance could be observed. Figure 8 shows the oscillographic traces obtained from the ac tests on the low-value resistors. For all practical purposes, it may be said that the 100-ohm and 500-ohm resistors showed no effect.

2. *1- and 10-kohm Resistors* – Making the assumption as above, it is noted that the apparent percentage changes for these resistors were very erratic, and no correlation could be made with the applied circuit voltage or repeated exposure. Table 1B shows the percentage changes tabulated

for these resistors. Peak changes in 1-kohm resistors ranged from +6.0 to −3.6, and from 16.7 to −43.8 in 10-kohm resistors. The only explanation that can be postulated is that the combination of cable and resistor effects produces a completely random behavior under the controls applied.

3. *100-kohm Resistors* – In Table 1B are tabulated the data obtained using the measuring circuit, Figure 4F. This circuit with symmetrical impedance to ground was used in an attempt to compensate for spurious cable effects in measurements of resistance change in the higher value resistor. Theoretically, if the cable effects were of the same magnitude, they could be made to cancel, and this is indeed the case with zero applied voltage. For other voltages, however, the data are seen to be inconsistent and improbable, ranging from an increase of 31% to 108% with one measurement implying a "negative" resistance (−147%). Apparently, although the circuit impedance is balanced, the presence of an applied voltage introduces asymmetry, and results in unequal cable signals which do not cancel. The lack of the desired compensation for spurious cable effects and the improbability of the results obtained preclude the use of this circuit for any valid measurement on high-value resistors.

Ferrite Cores – Although pronounced effects were noted in the tests on ferrite cores, the voltage changes observed during exposure (Table 1C) were essentially the same for each core regardless of the position of the core either inside the reactor building or outside. It, therefore, seems unlikely that the magnetic core properties are affected by direct exposure of the cores to the radiation pulses. Instead the pronounced voltage changes are probably due to radiation induced effects in the interconnecting coaxial cable (RG-62A/U). A change in cable resistance, discussed previously, is not likely a factor, since there are still pronounced voltage amplitude deviations even with a 10-kohm resistor shunting the core; decreases in resistance for the RG-62A/U cable are génerally to levels of the order of 500 kohms.[2] The possibility that the effect was caused by a decrease in the incremental permeability of the core by a current pulse induced in the cable was checked in the laboratory after the experiment, but it was found that a current sufficient to cause the amplitude changes shown in Table 1C had a permanent effect on the core permeability. Since there were no permanent radiation effects, the induced cable current could not be the sole factor. A likely cause for the observed behavior is a cable capacitance change, which can make the L-C circuit voltage decrease. Such capacitance changes were observed for the RG-62A/U cable in earlier experiments.[2]

Although it is not possible at this time to establish the exact nature of the cable contribution to the observed effect, it is believed that the observed effects are attributable to the cable and that the ferrite cores were not affected by direct irradiation.

CONCLUSIONS

1. There are pronounced effects in cables as a result of exposure to pulses of nuclear radiation. These effects can be responsible for an appreciable portion of the changes observed when cables are used in measuring other electronic parts. Neither the mechanisms by which the cable effects occur nor the individual factors that govern the cable behavior in this environment are clear. An attempt to subtract or compensate for the cable contribution in component part measurements with the current knowledge would be unreliable in many cases because of the random nature and magnitude of the cable effects. Some reliable measurements are possible, however, when the signal due to the effect in the electronic part is considerably greater than that of the spurious cable effect. Further studies must be directed at a thorough understanding of the nature and magnitude of cable response before measurements on all electronic parts can be considered reliable or representative.

2. Of the four looped cables tested, RG-59B/U proved to be the least affected under the nuclear pulse environments obtained. Lower signal levels, however, were observed in the

potted-end RG-62A/U cable. The additional cable length required for the looped configuration apparently contributed more to the observed cable effect than did the use of the potting compound. Since the RG-59B/U was the most stable of the looped cables, it is expected that its behavior in a potted-end straight configuration would be superior to that of the RG-62A/U.

3. There appeared to be no effect in the 100-ohm and 500-ohm resistors. The measurements on 1-kohm, 10-kohm, and 100-kohm resistors were erratic. The observed changes are probably a combination of resistor and cable effects which at present are not separable.

4. The large voltage changes in the ferrite inductor tests are also attributed to changes in transmission cable characteristics; namely, transient changes in capacitance. The core itself is in all probability unaffected.

ACKNOWLEDGMENTS

All phases of the reported experiment were conducted under the guidance and direction of Dr. E. Both.

Dr. Both and Dr. H. Degenhart participated in the planning of the experiment. Other members of the field team were Mr. G. C. Sands, M/Sgt J. C. Hendrickson, and Pfc R. L. Shakun. Dr. Degenhart, as consultant to the field team, made valuable contributions during the performance of the experiment.

Dr. H. Bruemmer and Pfc R. L. Shakun participated in the conversion of raw data to usable form.

The authors wish to acknowledge the many valuable contributions and suggestions made by Mr. J. Gruol in the preparation of this report.

REFERENCES

1. J. L. Colp and P. D. O'Brien, "The Sandia Pulse Reactor Facility," SCR-229, TID-4500, Reactors-General, August 1960.

2. H. J. Degenhart and W. Schlosser, "Pulsed Nuclear Radiation Effects on Electronic Parts and Materials," USASRDL Technical Report 2200, May 1961.

TABULATION OF DATA FOR PARTS EXPOSED

COAXIAL CABLES

TABLE 1A

PART	FIGURE	SHOT	MEAS. CKT. Fig.4B	APPLIED VOLTAGE	SCALE FACTORS Volts/Div#	Microsec/Div#	1 Peak MICROAMP
Coaxial Cable RG-81/U (loop) potted	14 A-1	1	R_L=10k Ω	+22	0.5	100	430*
	B-3	2	"	-22	0.5	100	-480*
	C-1	3	"	0	0.05	100	6.5
	D-1	4	"	-3	0.05	100	-35*
	E-1	5	"	Open Circuit	0.05	100	0.5
	F-2	6	"	3	0.5	200	40
	G-4	7	"	-90	0.5	200	-500*
	H-4	8	"	-90	5.0	200	-150
	15 C-4	11	R_L= 1k Ω	-200	0.5	200	-2650
	D-3	12	"	90	5.0	200	3000
	E-2	13	"	-90	0.5	200	-2050
	F-2	14	"	-6	0.05	200	400*
	G-2	15	"	-6	0.05	200	-6/7*
	H-3	16	"	-12	0.05	200	-115

#Values shown on this and succeeding tables represent the scale factor for a major division on the reproduced data photographs.

*Estimated Value

TABLE 1A COAXIAL CABLES (Cont.)

PART	FIGURE	SHOT	MEAS. CKT. Fig.4B	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	i Peak MICROAMP
Coaxial Cable RG-62A/U (loop) potted	14 A-2	1	R_L=10kΩ	22	0.5	100	600*
	B-2	2	"	-22	0.5	100	-480*
	C-2	3	"	0	0.05	100	8.5
	D-2	4	"	-3	0.05	100	4/-20
	E-2	5	"	Open Circuit	0.05	100	1
	F-3	6	"	3	0.05	200	35*
	G-3	7	"	-90	0.5	200	-180
	H-3	8	"	-90	5.0	200	-350
	15 A-3	9	R_L= 1kΩ	Open Circuit	0.05	200	25
	B-3	10	"	0	0.05	200	300*
	C-3	11	R_L=10KΩ	-45	0.5	200	-480*
	D-4	12	"	-12	0.05	200	50*
	E-1	13	"	-12	0.5	200	5*
	F-1	14	"	135	0.5	200	600*
	G-3	15	"	-12	0.5	200	(-)
	H-1	16	"	-200	5.0	200	-2500*

*Estimated Value

(-)Off Scale in the negative direction.

TABLE 1A COAXIAL CABLES (Cont.)

PART	FIGURE	SHOT	MEAS. CKT. Fig. 4B	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	Microsec/Div	i Peak MICROAMP
Coaxial Cable RG-59B/U (loop) potted	14 A-3	1	R_L=10KΩ	22	0.5	100	70
	B-1	2	"	-22	0.5	100	-100
	C-3	3	"	0	0.05	100	2.5
	D-3	4	"	-3	0.05	100	-5.5
	E-3	5	"	Open Circuit	0.05	100	8.5
	F-4	6	"	3	0.05	200	10
	G-2	7	"	-90	0.5	200	-250*
	15 A-1	9	"	90	0.5	200	300*
	B-1	10	"	200	5.0	200	250
	C-2	11	"	12	0.5	200	(-)
	D-2	12	"	45	0.5	200	90
	E-3	13	"	-200	5.0	200	-380
	F-3	14	"	-6	0.05	200	25*
	G-1	15	"	-6	0.05	200	-2.5/3.3
	H-4	16	"	-135	0.5	200	-270

*Estimated Value

(-)Off Scale in a negative direction

TABLE 1A COAXIAL CABLES (Cont.)

PART	FIGURE	SHOT	MEAS. CKT. Fig. 4B	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	Microsec/Div	i Peak MICROAMP
Twisted Pair (loop) potted	14 A-4	1	R_L=10K Ω	22	0.5	100	330*
	B-4	2	"	-22	0.5	100	-400*
	C-4	3	"	0	0.05	100	4.5
	D-4	4	"	-6	0.05	100	-55*
	E-4	5	"	Open Circuit	0.05	100	1.0
	F-1	6	"	6	0.5	200	60
	15 A-4	9	"	90	0.5	200	400*
	B-4	10	"	-90	5.0	200	-1000
	C-1	11	"	12	0.5	200	(+)
	D-1	12	"	45	0.5	200	380*
	E-4	13	"	-200	5.0	200	-1650
	F-4	14	"	-3	0.05	200	(+)
	G-4	15	"	-3	0.5	200	5
	H-2	16	"	-12	0.5	200	180*

*Estimated Value

(+)Off Scale in a positive direction.

TABLE 1A COAXIAL CABLES (Cont.)

PART	FIGURE	SHOT	MEAS. CKT. Fig. 4B	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	i Peak MICROAMP
Coaxial Cable	16 B-1	3	R_L=10K Ω	-22	0.1	100	-90*
RG-62A/U Potted End (Straight)	C-1	4	"	200	1.0	200	50
	E-1	6	"	0	0.1	200	-13
	F-1	7	"	-200	0.2	200	-44
	G-1	8	"	-90	0.1	200	-34
	H-1	9	"	3	0.2	100	80*
	17 A-1	10	"	6	0.5	200	12.5
	B-1	11	"	-45	1.0	200	-80
	C-1	12	"	-12	0.1	100	7.5
	D-1	13	"	-12	0.1	100	17.5
	E-2	14	"	135	0.5	200	50
	F-1	15	"	-135	1.0	200	-80
	G-1	16	"	-6	0.1	100	60*
	H-1	17	"	-6	0.2	100	3
	I-1	18	"	-6	0.2	100	5

*Estimated Value

TABLE 1A COAXIAL CABLES (Cont.)

PART	FIGURE	SHOT	MEAS. CKT. Fig.4B	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	i Peak MICROAMP
Coaxial Cable	16 A-2	2	R_L= 1K Ω	22	0.5	100	250
RG-62A/U Unpotted End (Straight)	B-2	3	R_L=10K Ω	-22	0.1	100	-100*
	C-2	4	"	200	1.0	200	800
	D-2	5	"	0	0.05	200	(-)
	E-2	6	"	0	0.1	200	-27
	F-2	7	"	-200	0.5	200	-500*
	G-2	8	"	-200	0.5	200	-340*
	H-2	9	"	3	0.2	100	200*
	17 A-2	10	"	-3	1.0	200	-25
	B-2	11	"	-45	1.0	200	-360
	D-2	13	"	-12	0.2	100	-8
	E-1	14	"	135	1.0	200	600*
	F-2	15	"	-135	1.0	200	-500*
	G-2	16	"	-6	0.1	100	95*
	H-2	17	"	-6	0.5	100	5
	I-2	18	"	-6	0.5	100	12.5

*Estimated Value
(-)Off Scale in a negative direction

TABULATION OF DATA FOR PARTS EXPOSED

TABLE 1B

RESISTORS

DESCRIPTION	FIGURE & CURVE #	SHOT	MEAS. CKT.	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	ΔV MAX(Volts)	$\Delta R/R_o$ MAX(%)
100Ω, $\frac{1}{2}$W, C. Film	7 A-1	2	Fig.4A	6	0.05	100	0	0
	7 B-1	3	"	12	0.05	100	0	0
	7 C-1	4	"	-22	0.05	100	0.005	-0.09
	7 D-1	5	"	0	0.05	500	0	Indeterminate
	7 E-1	6	"	22	0.05	100	-0.005	-0.09
	7 F-1	7	"	-45	0.05	100	0	0
100Ω, $\frac{1}{2}$W, C. Film	7 A-2	2	Fig.4C (R_L=100Ω)	6	0.05	100	0	0
	7 B-2	3	"	12	0.05	100	-0.0025	-0.08
	7 C-2	4	"	-22	0.05	100	0.005	-0.09
	7 D-2	5	"	0	0.05	500	0	0
	7 E-2	6	"	22	0.05	100	-0.005	-0.09
	7 F-2	7	"	-45	0.05	100	0.005	-0.04
100Ω, $\frac{1}{2}$W, C. Film	8 A	1	Fig.4E (R_L=100Ω)	3 VAC	1.0	100	0	0

p.1 of 5p.

TABULATION OF DATA FOR PARTS EXPOSED (Cont.)
TABLE 1B (Cont.)

RESISTORS

DESCRIPTION	FIGURE & CURVE #	SHOT	MEAS. CKT.	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	ΔV MAX(Volts)	ΔR/R. MAX(%)
	8B	2	"	3 VAC	1.0	100	0	0
	8C	3	"	3 VAC	1.0	100	0	0
100Ω, ½W, C. Film	12 E-1	6	Fig.4C (R_L=500Ω)	22	0.05	500	-0.005	-0.14
500Ω, ½W, C. Film	8D	4	Fig.4E (R_L=500Ω)	3 VAC	0.2	50	0	0
	8E	5	"	3 VAC	0.2	50	0	0
1kΩ, ½W, C. Film	12 F-2	8	Fig.4C (R_L=500Ω)	-45	0.1	200	0.16	-1.6
	12 G-2	9	"	-3	0.05	200	-0.04	6.0
	12 H-2	10	"	-3	0.05	200	0	0
	13 A-1	11	"	22	0.05	500	-0.2	4,0
	13 B-2	12	"	-22	0.05	200	0.14	-2.8
	13 C-2	13	"	-6	0.05	200	-0.048	-3.6

TABULATION OF DATA FOR PARTS EXPOSED (Cont.)

TABLE IB(Cont.)

RESISTORS

DESCRIPTION	FIGURE & CURVE #	SHOT	MEAS. CKT.	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	ΔV MAX(Volts)	$\Delta R/R_o$ MAX(%)
10KΩ, $\frac{1}{2}$W, C. Film	9 A-1	3	Fig.4A (R_L=10KΩ)	-200	1.0	100	4.0	-7.2
	9-B-2	4	"	-90	0.5	200	-1.3	5.7
	9 C-1	5	"	-90	0.2	100	0.8	-3.5
	9 D-2	6	"	-90	0.2	100	0.38	-1.7
	10 B-1	12	Fig.4B (R_L=10KΩ)	0	0.5	100	0	Indeterminate
	10 C-1	13	"	0	0.05	100	-0.033	Indeterminate
	10 D-1	14	"	-12	0.2	100	0.15	-5.0
	10 E-1	15	"	12	0.1	100	-0.65	-21.6
	10 F-2	16	"	-6	0.1	100	0	0
	10 G-1	17	"	-6	0.05	100	-0.008	0.5

TABULATION OF DATA FOR PARTS EXPOSED (Cont.)

TABLE 1B(Cont.)

RESISTORS

DESCRIPTION	FIGURE & CURVE #	SHOT	MEAS. CKT.	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	ΔV MAX(Volts)	ΔR/R₀ MAX(%)
10KΩ, $\frac{1}{2}$W, C. Film	9 A-2	3	Fig.4C (R_L=10KΩ)	-90	0.1	100	0.9	-4.0
	9 B-1	4	"	90	1.0	200	0.8	3.6
	9 C-2	5	"	90	0.5	100	-3.3	-14.7
	9 D-1	6	"	90	0.5	100	-0.75	-3.3
	10 A-2	11	Fig.4C (R_L=10KΩ)	-3	0.1	100	0.05	-6.7
	10 B-2	12	"	-22	0.2	100	0.59	-10.8
	10 C-2	13	"	-45	0.5	100	0.68	-6.0
	10 D-2	14	"	-12	0.2	100	-0.5	16.7
	10 E-2	15	"	6	0.1	100	-0.65	-43.3
	10 F-1	16	"	-6	0.2	100	0.3	-20
	10 G-2	17	"	-6	0.2	100	-0.11	7.3
100KΩ $\frac{1}{2}$W, C. Film	11 A$^{A1}_{B2}$	10	Fig.4F (Ro/2=50KΩ)	0 (Short)	1.0	500	-0.7 -0.7	Indeterminate
	11 B$^{A1}_{B2}$	11	"	0 (Open)	0.5	500	0 -0.65	Indeterminate
	11 C$^{A1}_{B2}$	12	"	3	0.5	500	0.35 -0.2	73

TABULATION OF DATA FOR PARTS EXPOSED (Cont.)

TABLE 1B (Cont.)

RESISTORS

DESCRIPTION	FIGURE & CURVE #	SHOT	MEAS. CKT.	APPLIED VOLTAGE	SCALE FACTORS Volts/Div	Microsec/Div	ΔV MAX (Volts)	ΔR/R_o MAX(%)
	11 D A 1, B 2	13	"	-6	0.5	200	-2.2 -0.65	103
	11 E A 2, B 1	14	"	22	0.5	500	+Off scale +Off Scale	Indeterminate
	11 F A 1, B 2	15	"	6	1.0	200	-4.2 -2.0	-147
	11 G A 1, B 2	16	"	9	2.0	200	0.6 0	27
	11 H A 2, B 1	17	"	9	0.5 0.1	100	-0.5 -0.01	22
	11 I A 2, B 1	18	"	9	0.5 0.1	100	-0.7 -0.02	31
100Ω, 10w, wire wound	13 D-1	14	Fig.4C (R_L=500Ω)	12	0.1	200	0	0
	13 E-1	15	"	12	0.05	200	0	0
	13 F-1	16	"	-3	0.05	200	0.005	-1.2
	13 G-1	17	"	-3	0.05	500	0	0
	13 H-2	18	"	-3	0.05	500	0	0

TABULATION OF DATA FOR PARTS EXPOSED

TABLE 1C

FERRITE INDUCTORS

PART	FIGURE	SHOT	CORE	SHUNT RESISTOR	DET. CIRCUIT	SCALE FACTORS Volts/Div	SCALE FACTORS Microsec/Div	Δ V%
Ferrite Inductor (Manganese-Zinc)	18 A	6	At Reactor	None	4D	1.0	100	-42
	B	7	Outside Reactor	None	"	1.0	100	-46
	C	8	Outside Reactor	10Kohm at Reactor	"	0.5	100	-45
	D	9	Outside Reactor	10Kohm outside Reactor	"	1.0	100	-33
	E	10	Outside Reactor	100Kohm outside Reactor	"	1.0	100	-49
	F	11	Outside Reactor	100Kohm at Reactor	"	1.0	100	-50
	19 A	12	Outside Reactor	100Kohm outside Reactor	"	2.0	100	-58
Ferrite Inductor (Nickel-Zinc)	B	14	At Reactor	None	4D	1.0	100	-47
	C	15	Outside Reactor	None	"	0.5	100	-39
	D	16	2" Back from Reactor	None	"	0.5	100	-40

TABULATION OF DATA FOR PARTS EXPOSED (Cont.)

TABLE 1C (Cont.)

FERRITE INDUCTORS

PART	FIGURE	SHOT	CORE	SHUNT RESISTOR	DET. CIRCUIT	SCALE FACTORS		$\Delta V\%$
						Volts/Div	Microsec/Div	
	E	17	60" Back from Reactor	None	4D	0.5	100	-30
	F	18	60" Back from Reactor	None	"	0.5	100	-32

DOSIMETRY DATA

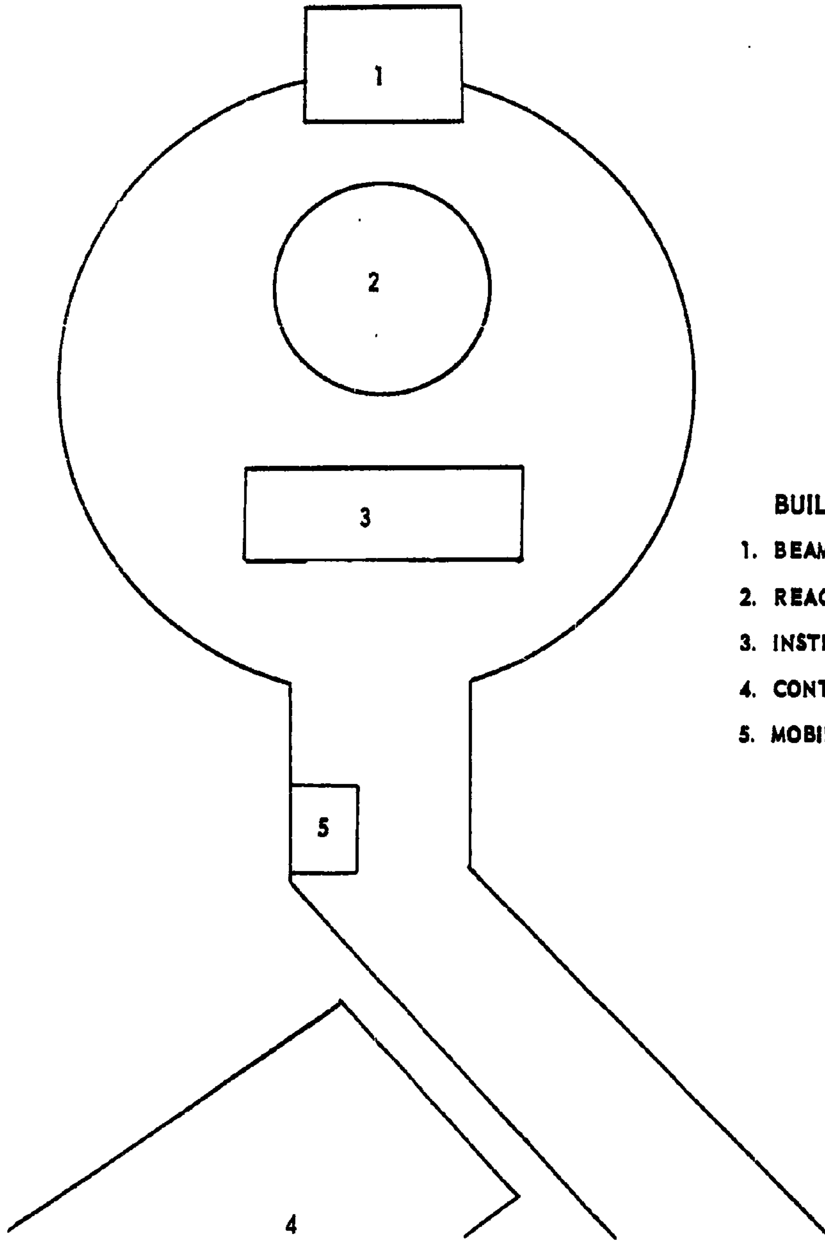
TABLE 2

SHOT	Temp. Change(°C)	Time Interval (Minutes)	Energies (Mev) 0.01 Pu	0.7 Np	1.5 U	$\times 10^{12}$ 3.0 S	Gamma Rad(H_2O) Glass Rod
1	92.5	0	-	-	-	0.88	-
2	90.1	126	-	-	-	1.4	-
3	93.3	124	7.8	3.9	2.2	1.5	-
4	94.0	987	-	-	-	2.3	-
5	85.4	111	5.9	3.0	2.3	1.3	3300
6	88.2	115	-	-	-	1.5	2700
7	85.3	122	-	-	-	1.1	2700
8	96.6	105	-	-	-	1.0	1750
9	89.8	990	5.5	2.2	1.6	0.78	3800
10	84.5	108	-	-	-	1.5	1500
11	93.2	105	-	-	-	0.73	2500
12	86.2	99	-	-	-	0.64	1700
13	95.9	123	6.9	3.6	2.1	0.69	1900
14	93.0	997	-	-	-	-	1900
15	94.3	141	-	-	-	1.3	1900
16	92.0	101	-	-	-	0.55	2700
17	84.6	113	-	-	-	0.77	4000
18	92.8	98	-	-	-	0.72	2100

eg. Shot 15 / Shot 16 = 101 Minutes between Shot 15 and Shot 16

Dosimetry was available only as tabulated.

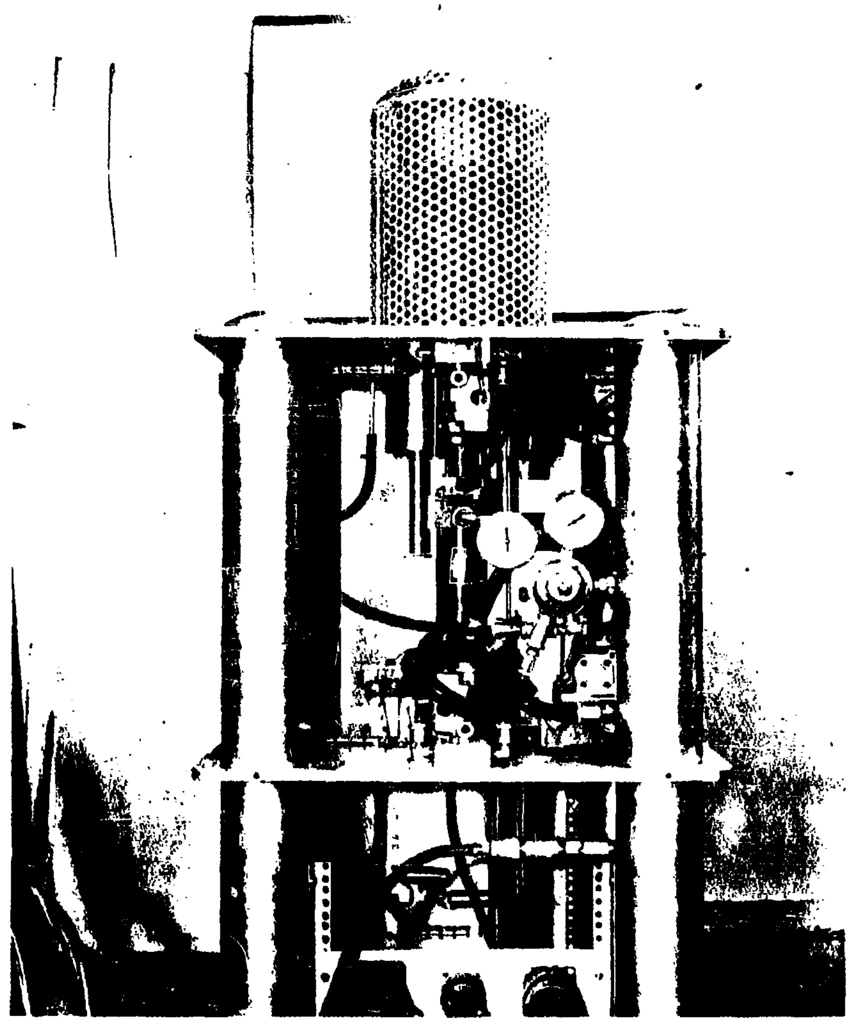
SANDIA PULSED REACTOR FACILITY



BUILDINGS

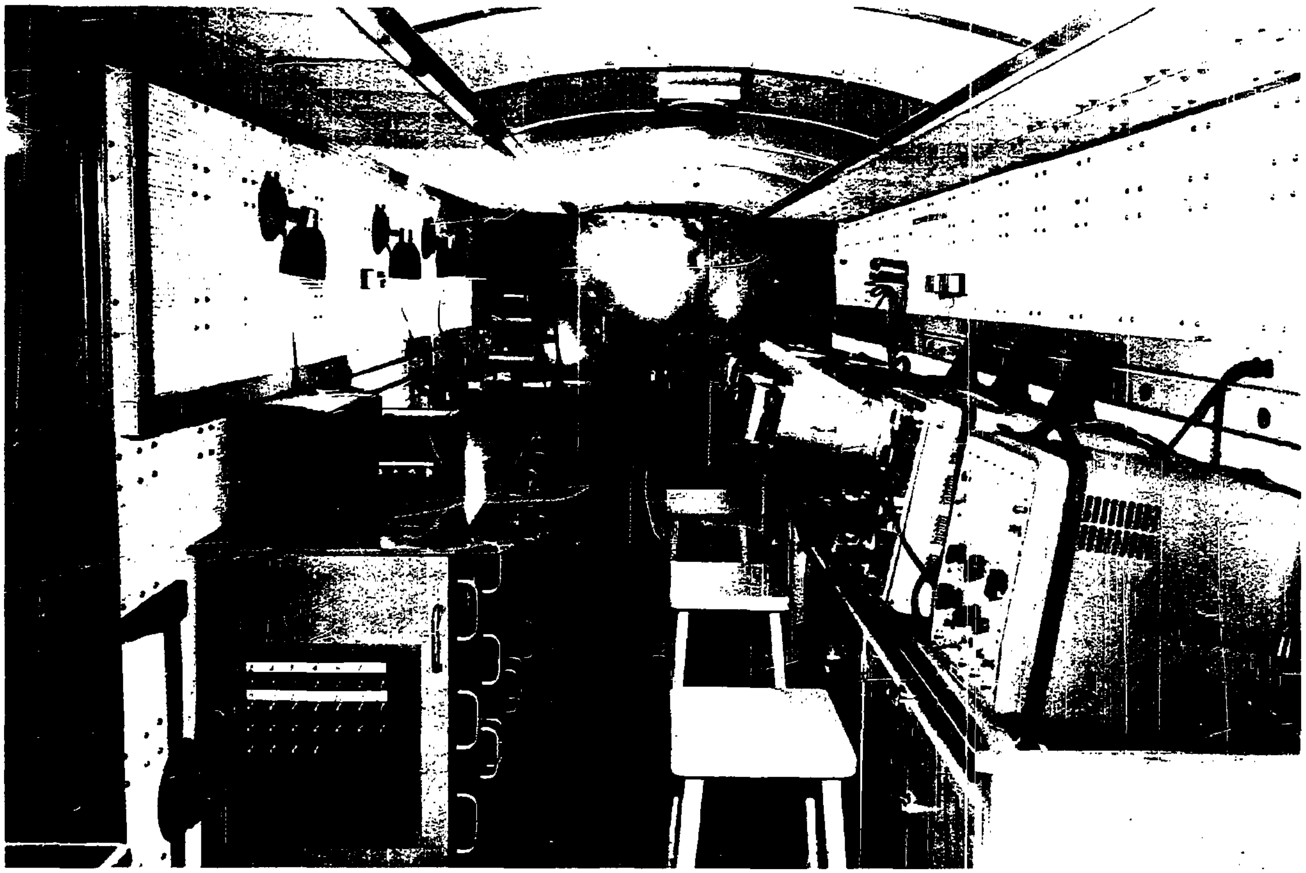
1. BEAM-CATCHER
2. REACTOR
3. INSTRUMENTATION
4. CONTROL & OPERATIONS
5. MOBILE LAB.

FIGURE 1.



Sandia Pulsed Reactor (SPR)

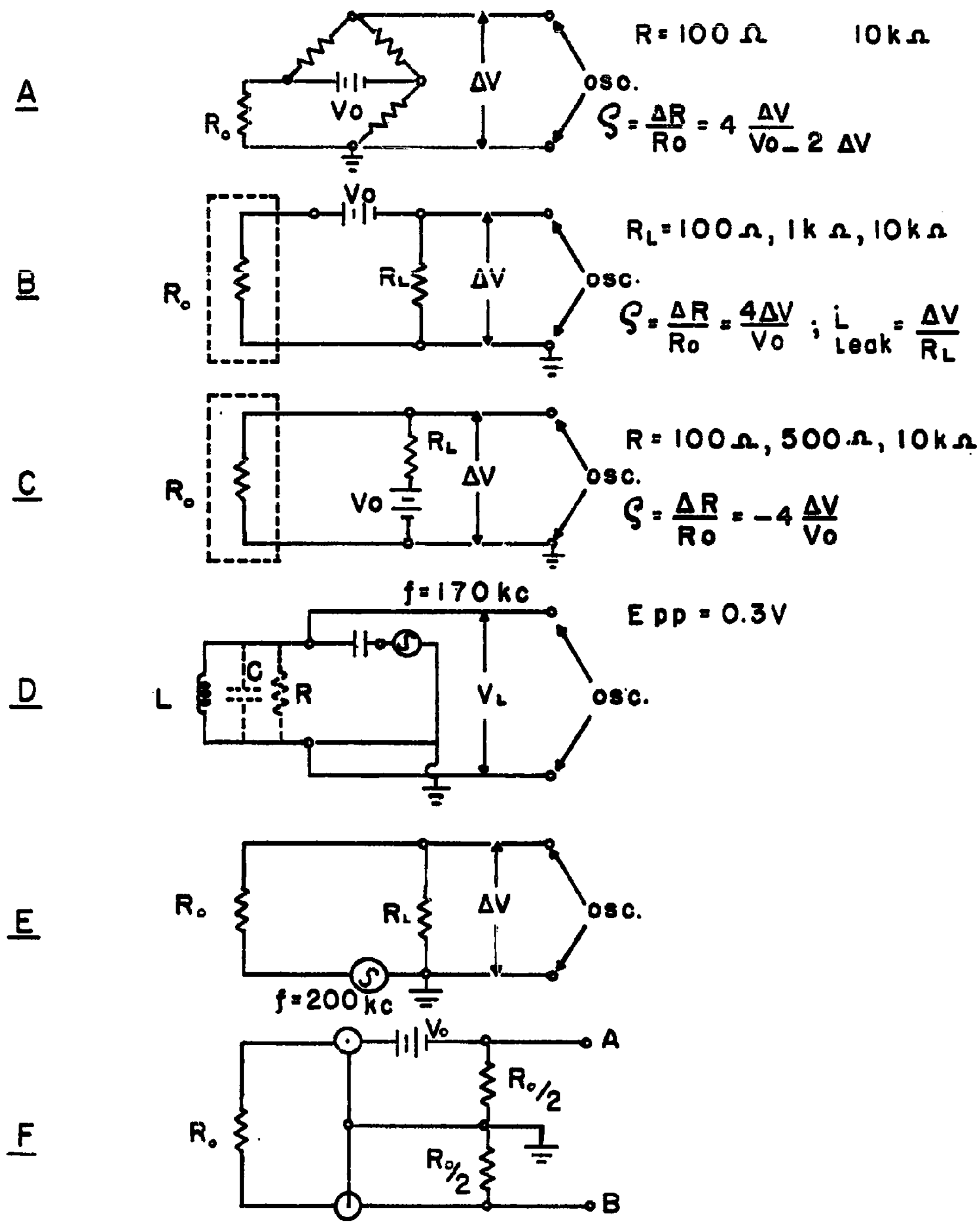
Figure 2



RADIATION EFFECTS MOBILE LABORATORY . (LAB. DESIGNED)
INSTALLED IN SEMI-TRAILER VAN M-348
INTERIOR VIEW . SHOWING FRONT TO REAR

FIGURE 3

DETECTION CIRCUITS . Fig. 4



TEST SETUP FOR CABLE LOOPS

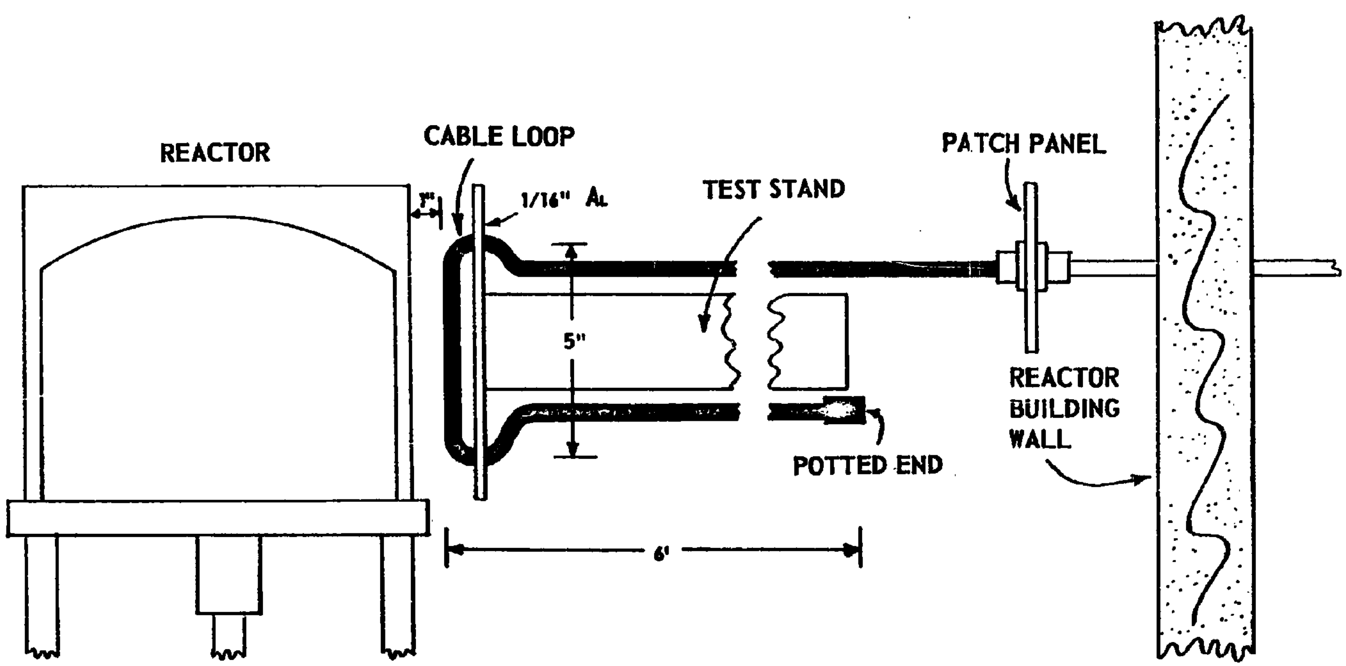


FIGURE 5.

TEST SETUP FOR STRAIGHT CABLES

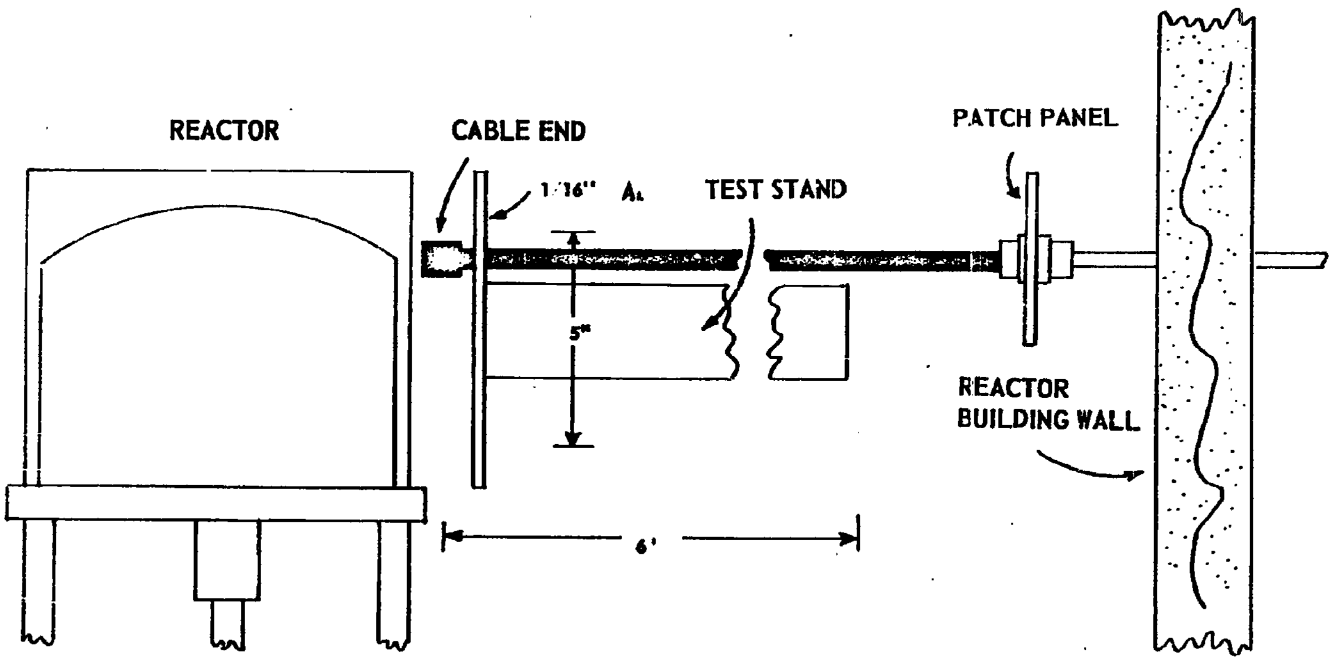
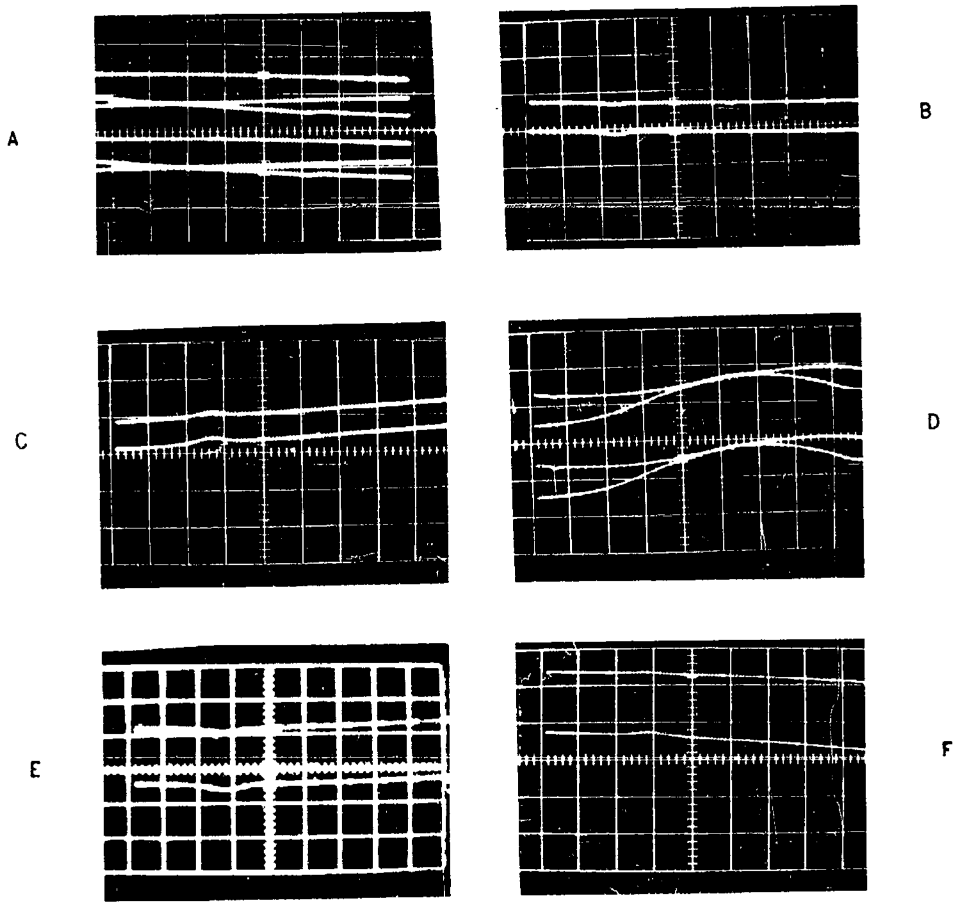


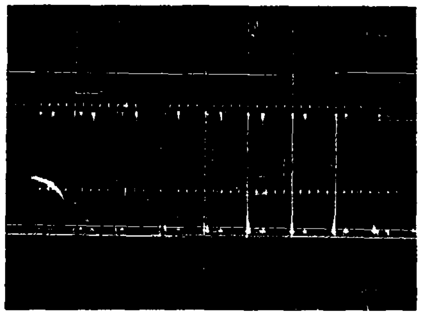
FIGURE 6.

FIGURE 7

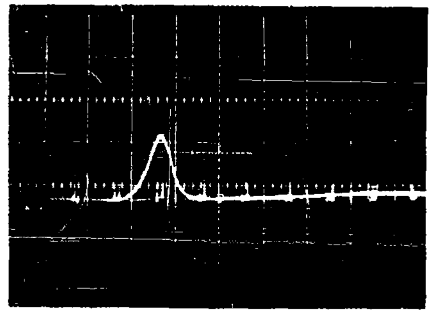


Photographs of Original Data

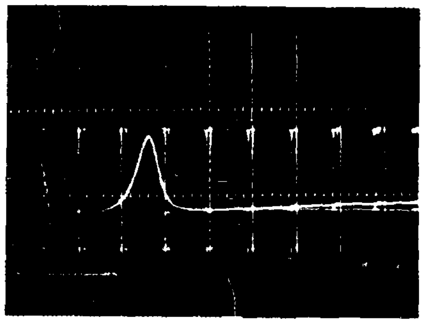
A



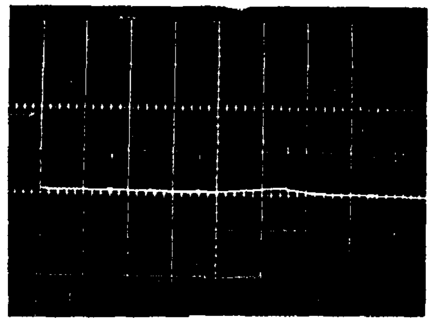
B



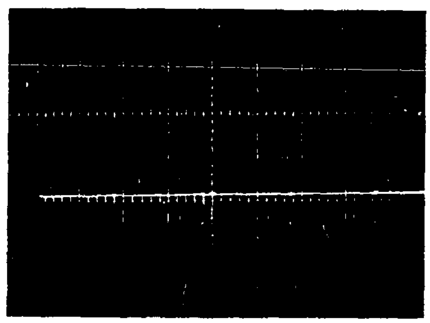
C



D

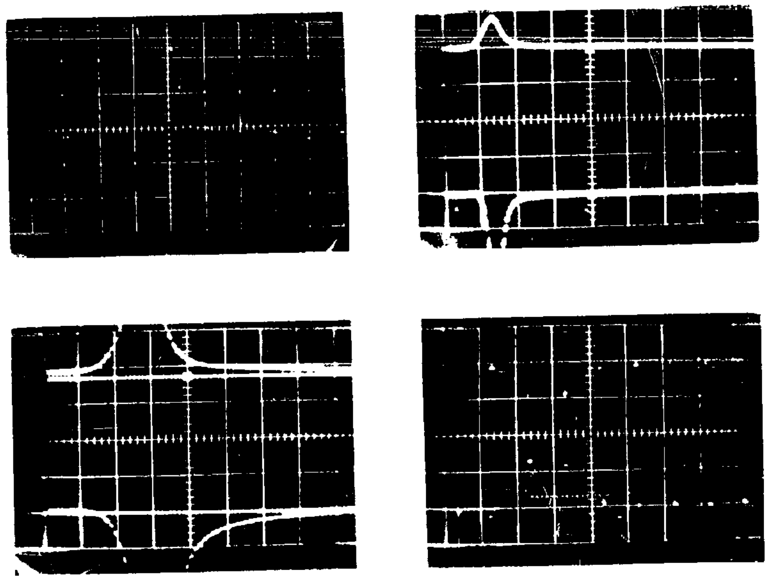


E



Photographs of Original Data

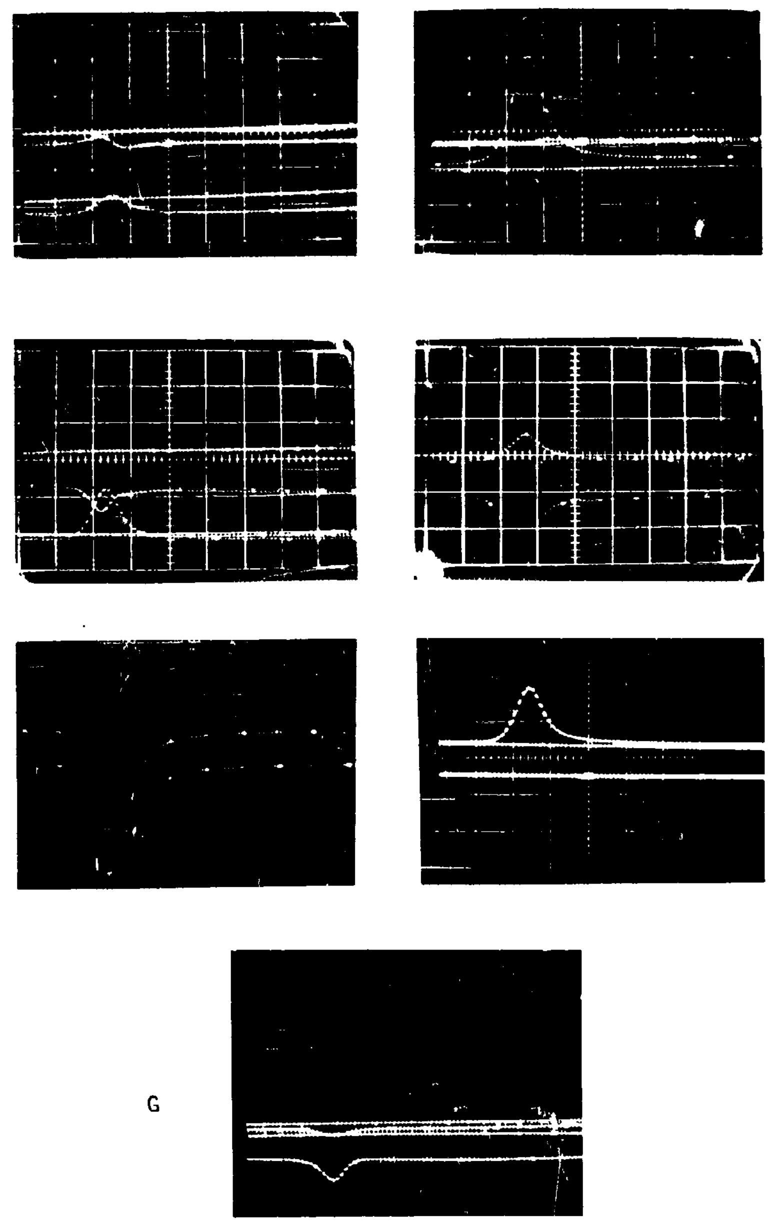
FIGURE 9



A B C D

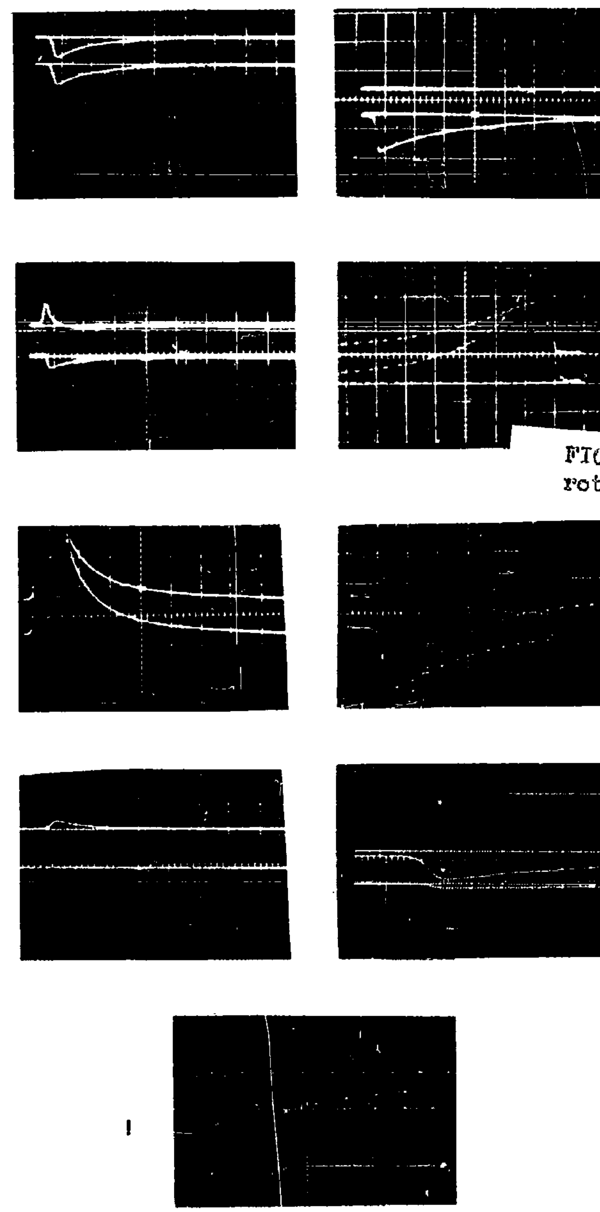
Photographs of Original Data

FIGURE 10



Photographs of Original Data

FIGURE 11

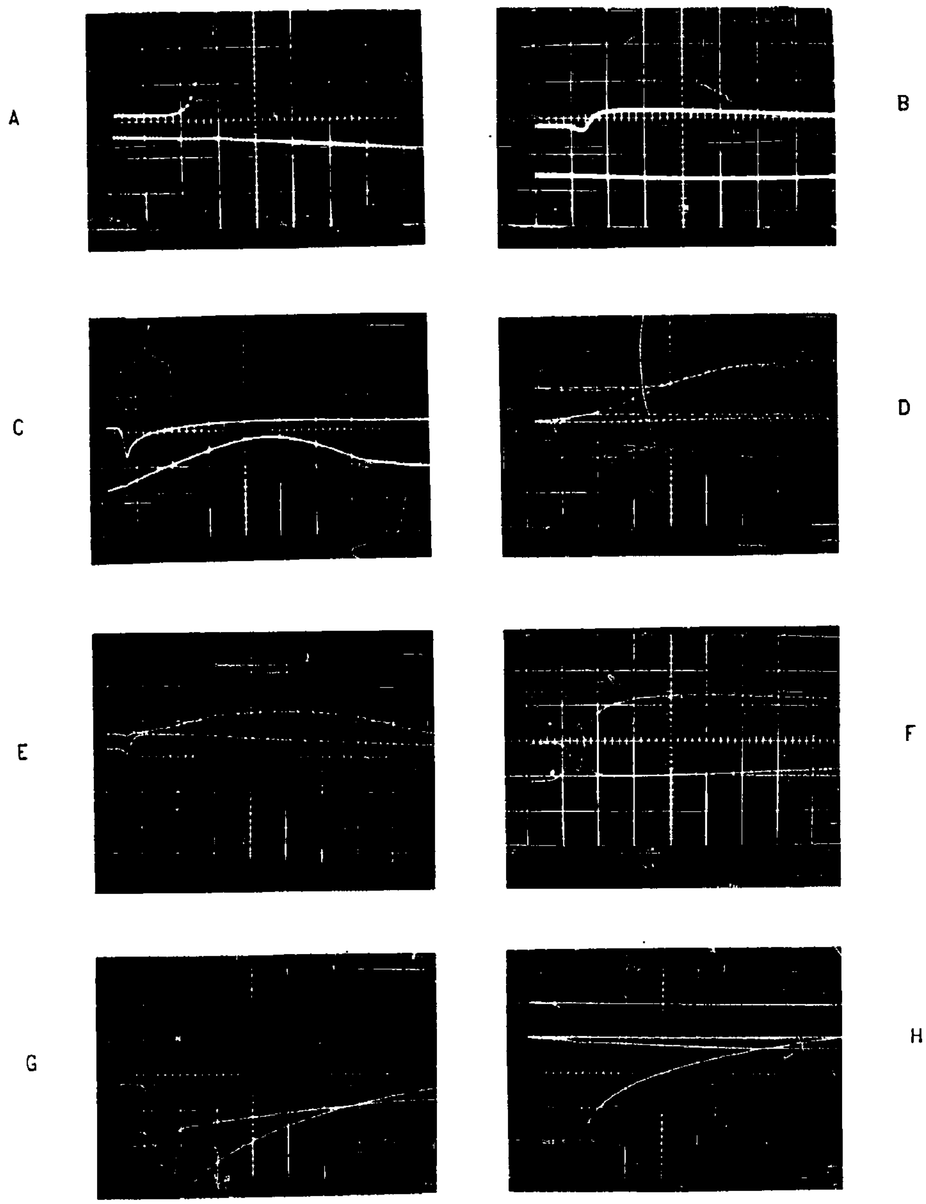


A B C D E F G H I

FIGURE 11 D should be rotated 180°.

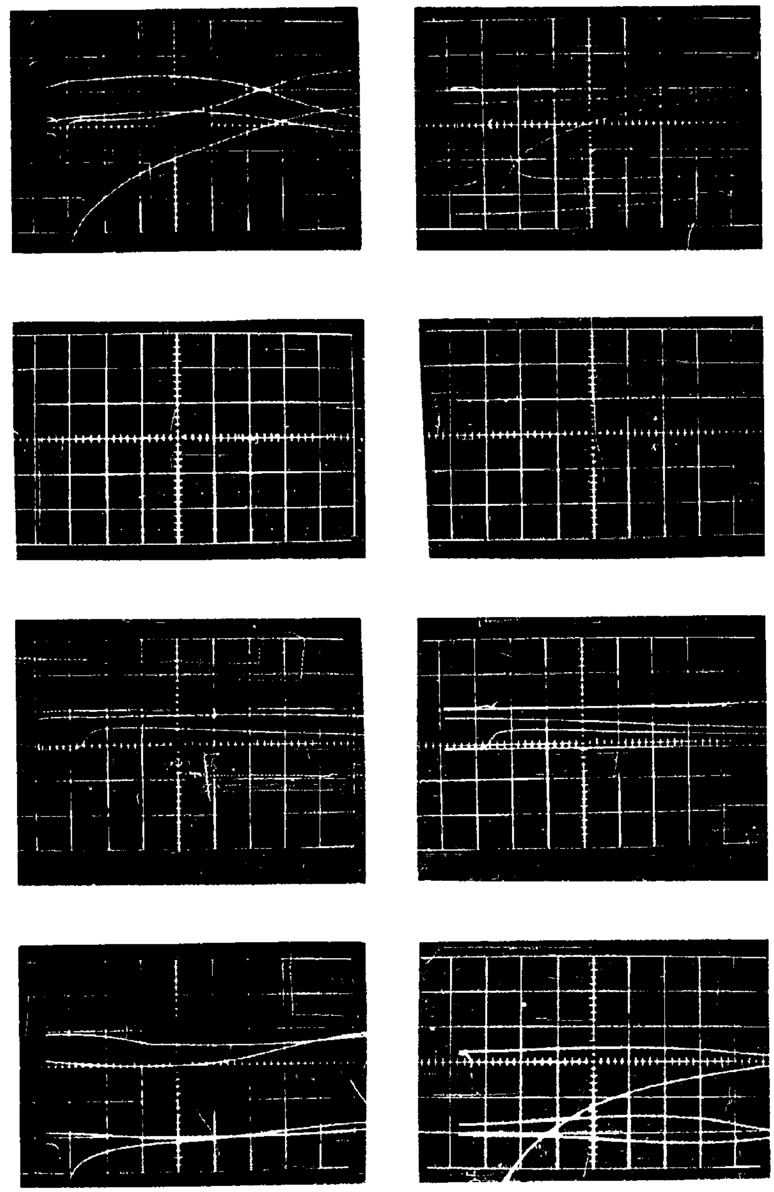
Photographs of Original Data

FIGURE 12



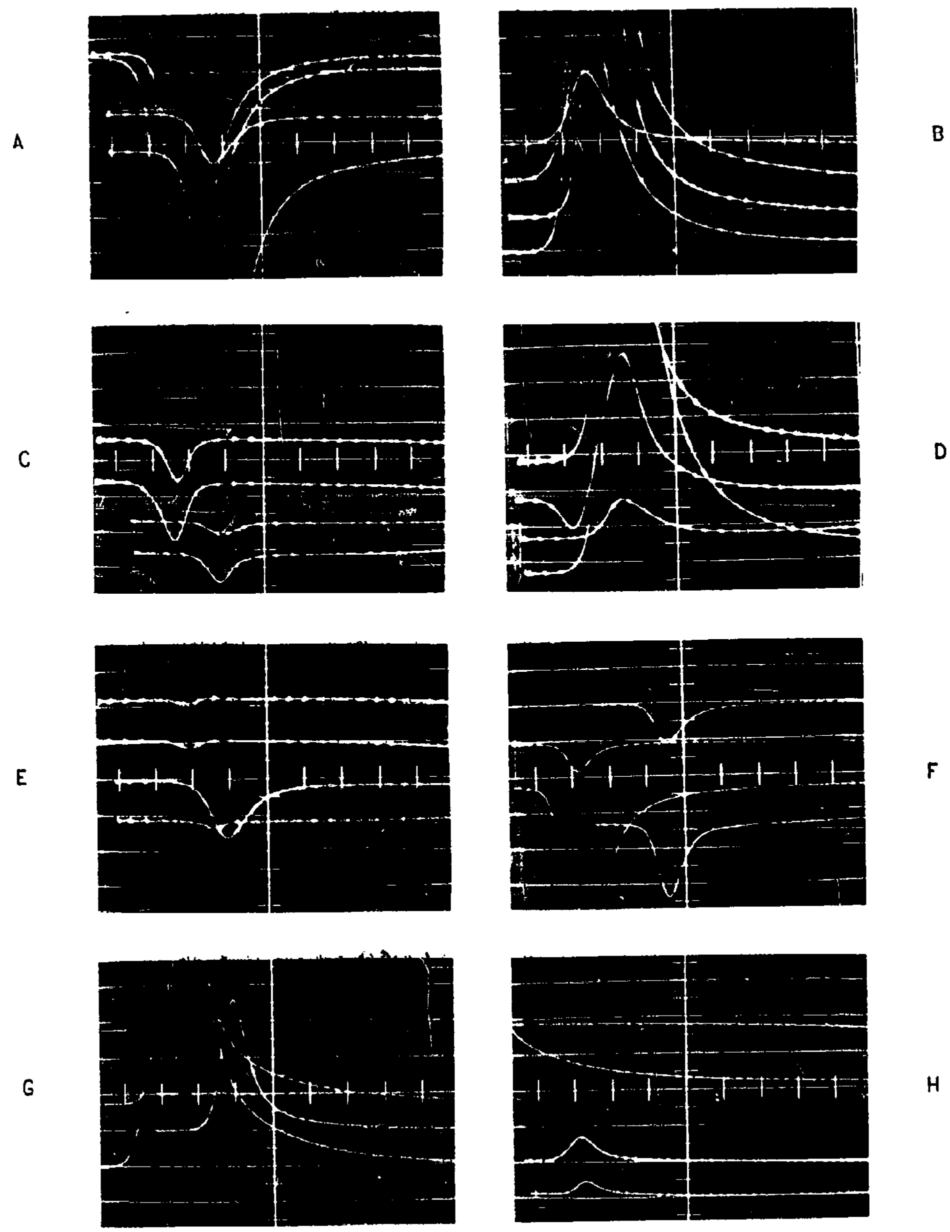
Photographs of Original Data

FIGURE 13



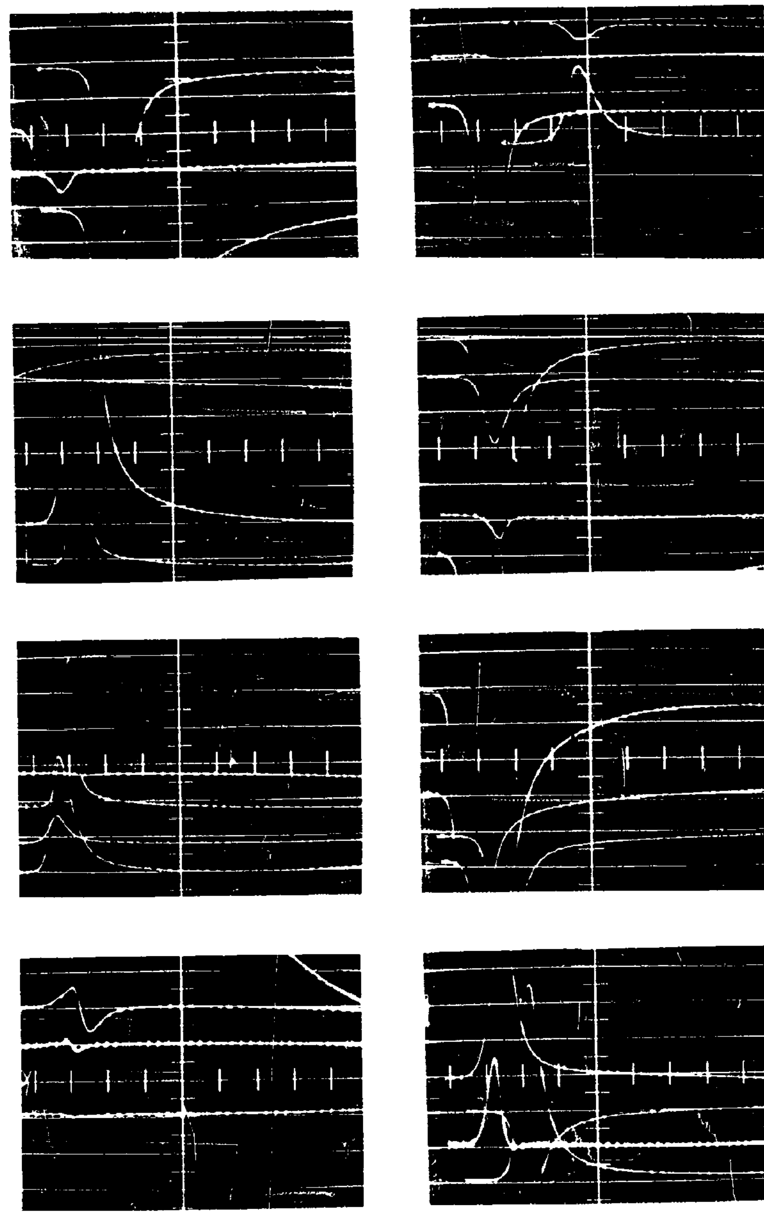
Photographs of Original Data

FIGURE 14



Photographs of Original Data

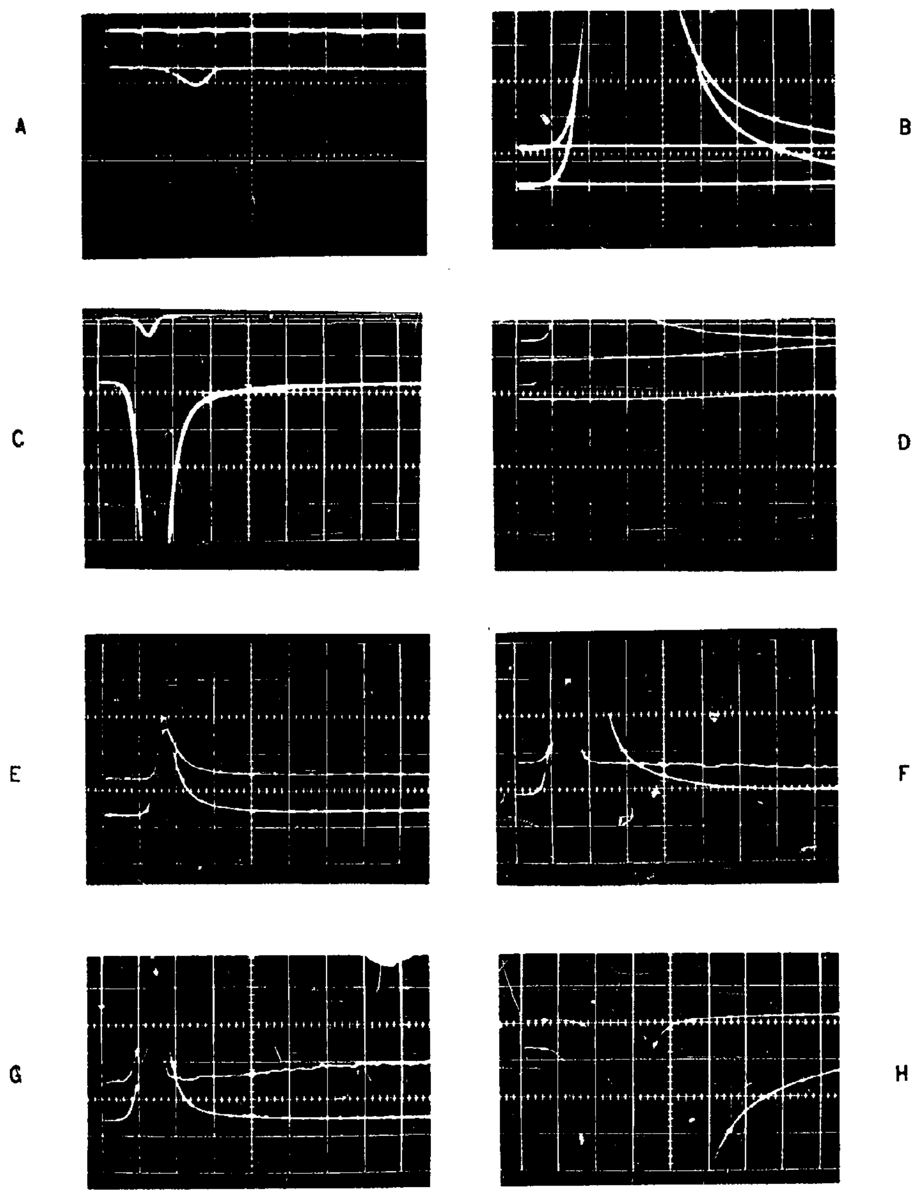
FIGURE 15



A B C D E F G H

Photographs of Original Data

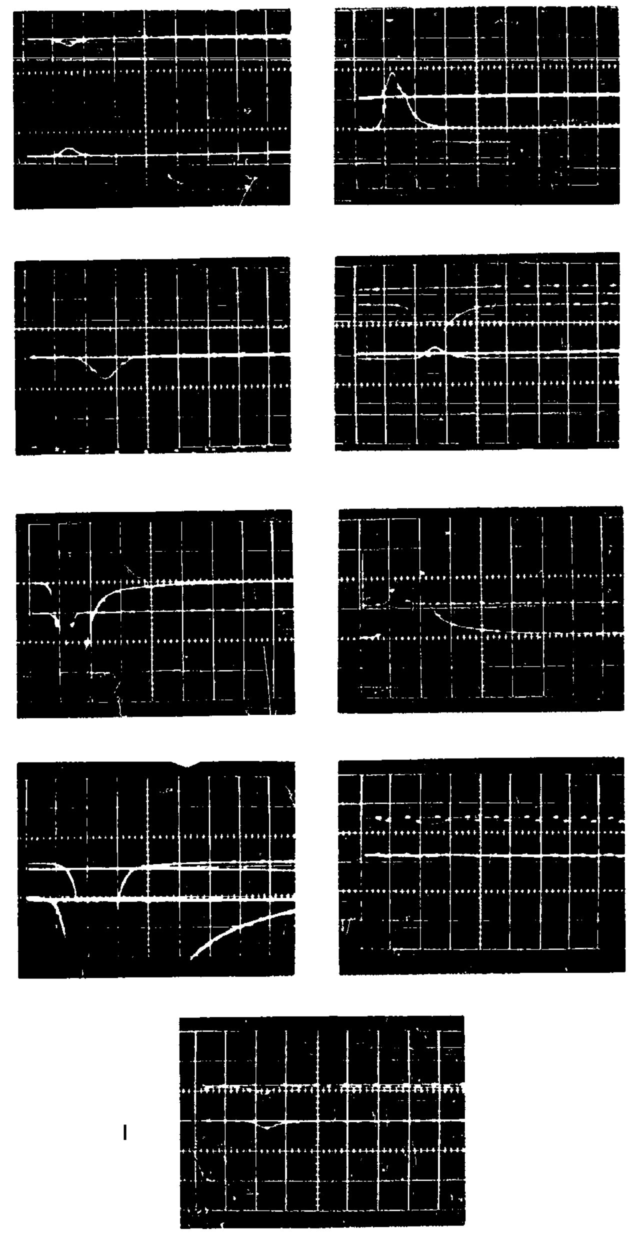
FIGURE 16



Photographs of Original Data

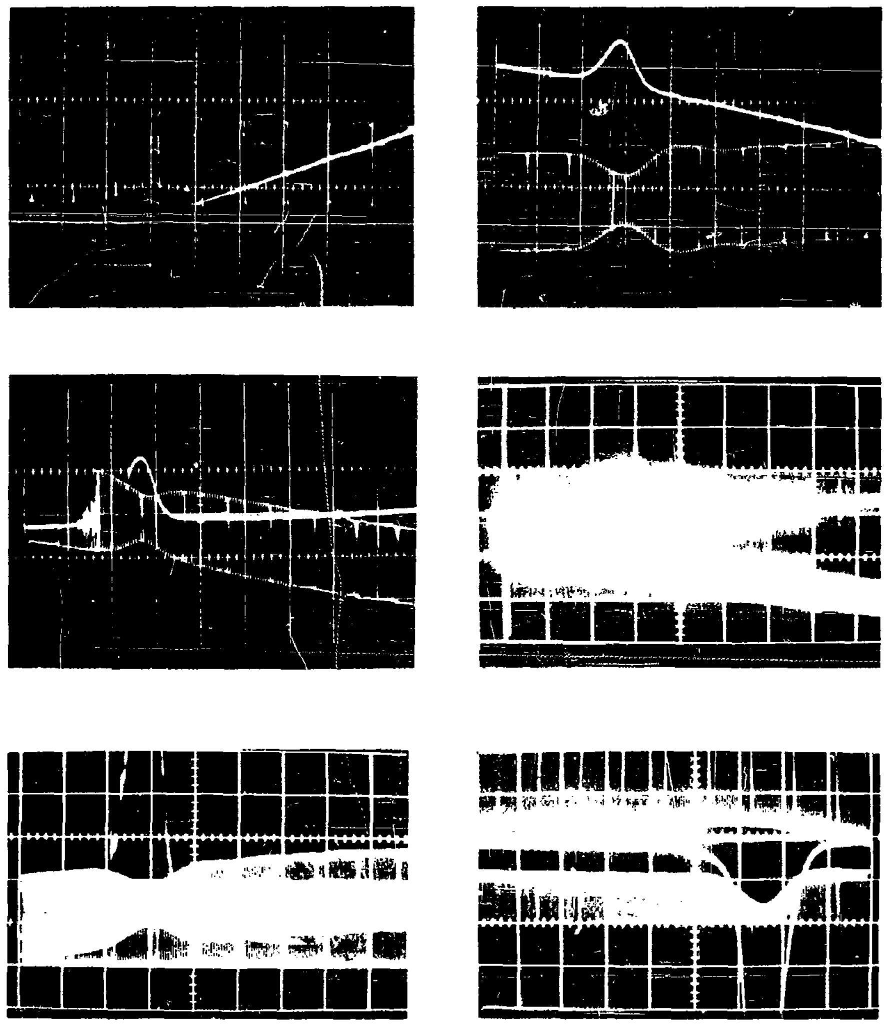
FIGURE 17

A B C D E F G H I



Photographs of Original Data

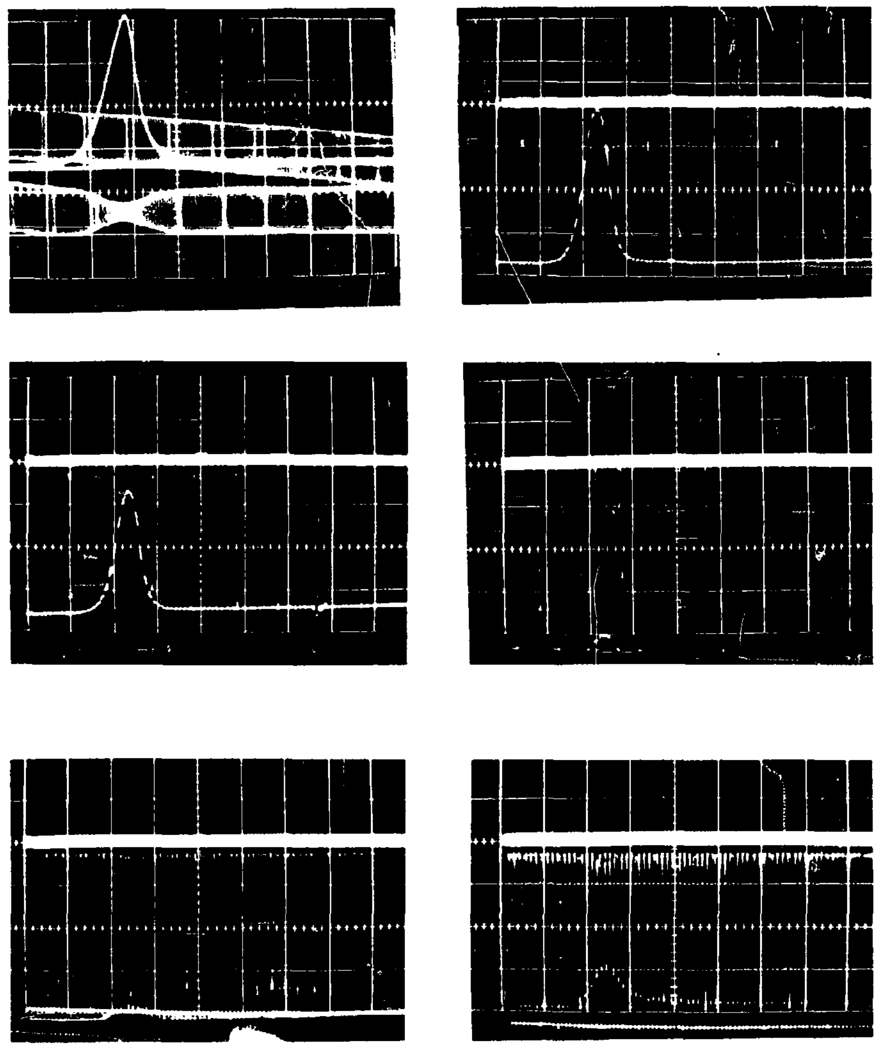
FIGURE 18



A B C D E F

Photographs of Original Data

FIGURE 19



Photographs of Original Data

CABLE DIAGRAMS

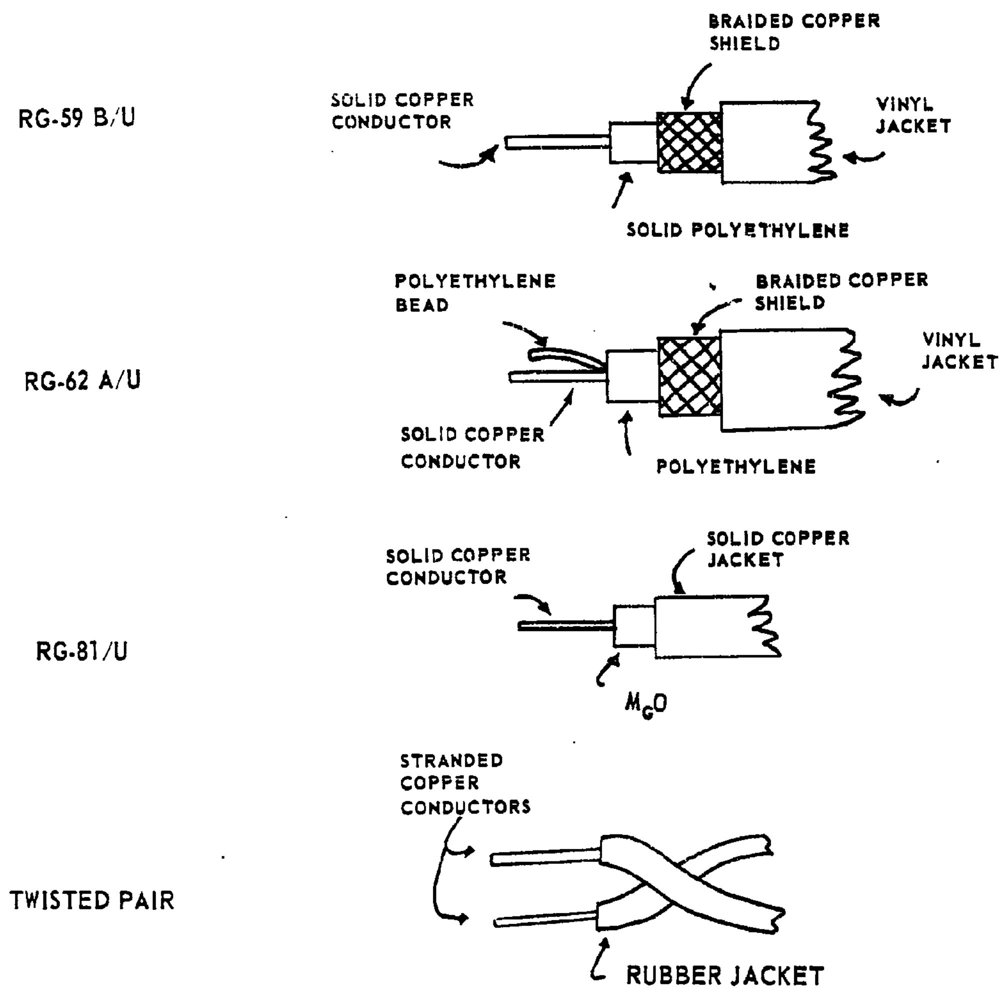
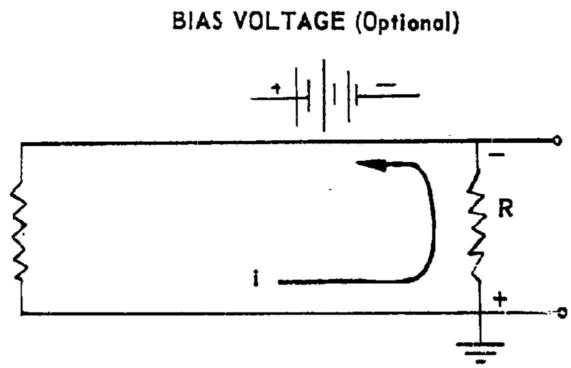


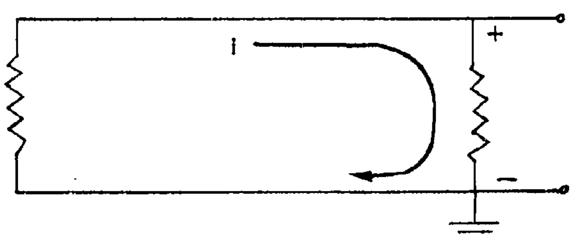
FIGURE 20.

DEFINITION OF CURRENT POLARITY



POSITIVE CURRENT FLOW

(Electrons Flowing to Ground via Measuring Resistor R)



NEGATIVE CURRENT FLOW

(Electrons Flowing into Off-Ground Conductor via Measuring Resistor R)

FIGURE 21.

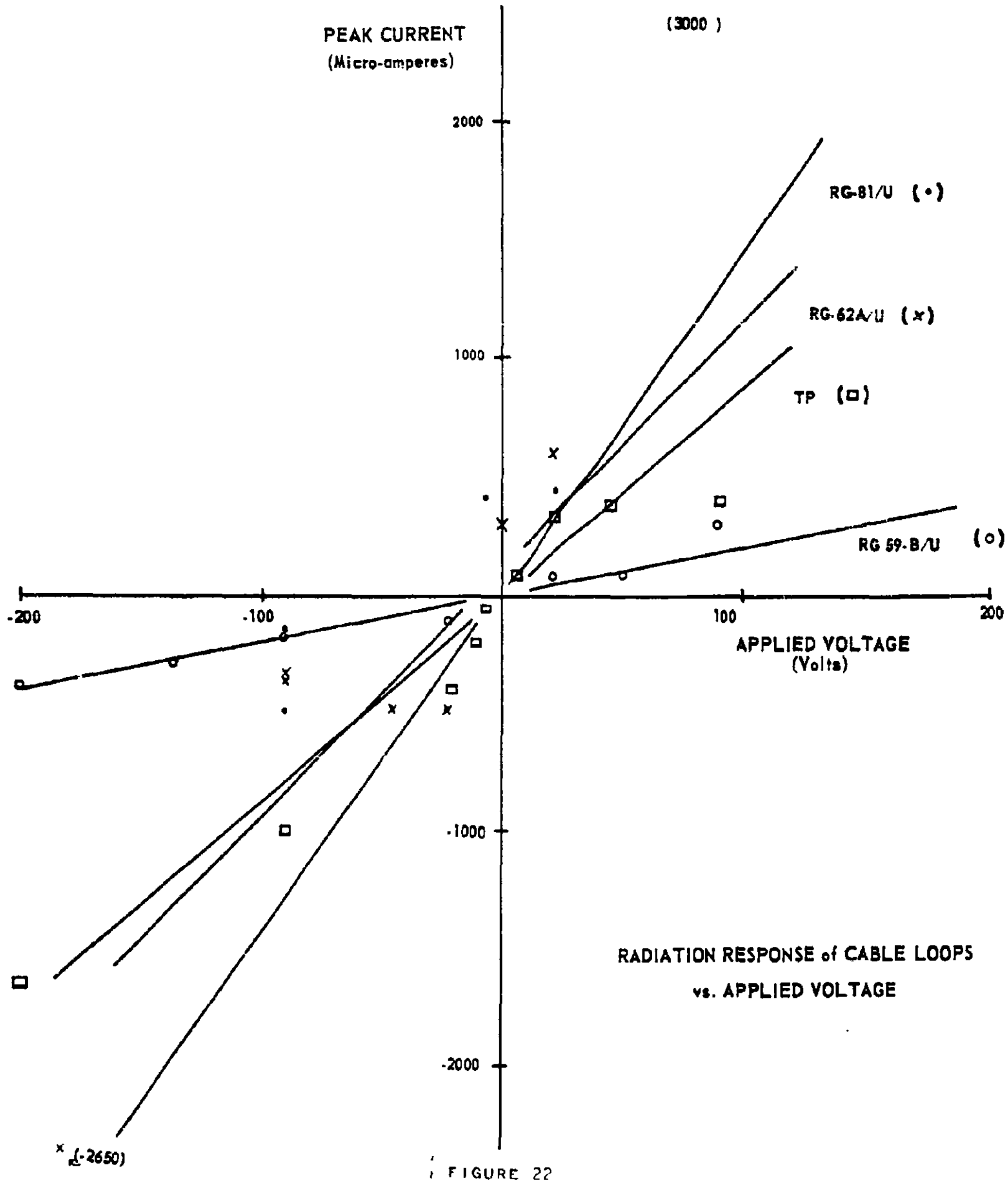

PEAK CURRENT
(Micro-amperes)
(3000)
2000
1000
-1000
-2000
-200
-100
100
200
APPLIED VOLTAGE
(Volts)
RG-81/U (•)
RG-62A/U (x)
TP (□)
RG 59-B/U (o)
x (-2650)
RADIATION RESPONSE of CABLE LOOPS
vs. APPLIED VOLTAGE

FIGURE 22

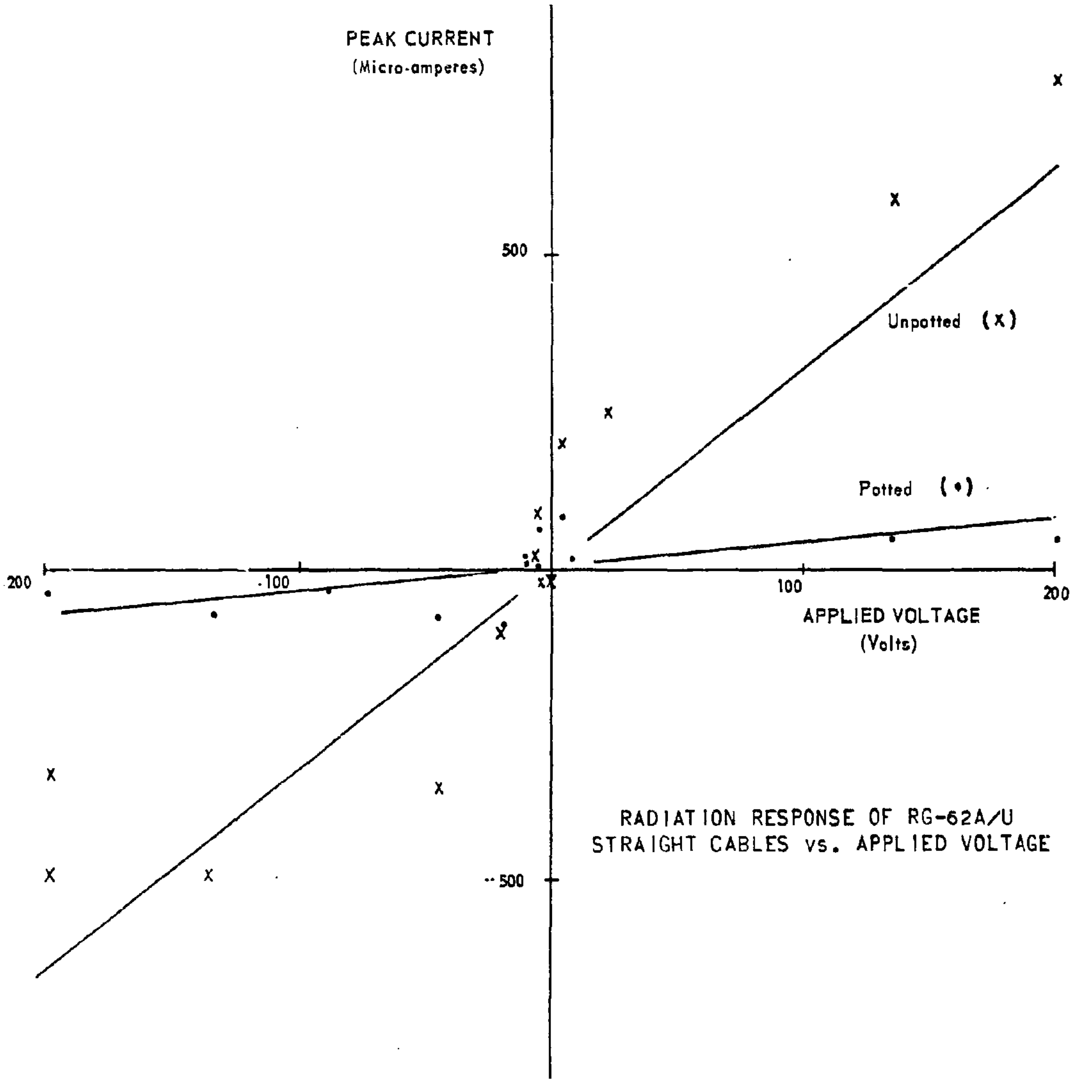

PEAK CURRENT
(Micro-amperes)
500
-500
200
-100
100
200
APPLIED VOLTAGE
(Volts)
Unpotted (X)
Potted (•)
RADIATION RESPONSE OF RG-62A/U
STRAIGHT CABLES vs. APPLIED VOLTAGE

FIGURE 23

DISTRIBUTION LIST

	Copies
Commanding General U. S. Army Electronics Command ATTN: AMSEL-AD Fort Monmouth, New Jersey	3
Office of the Assistant Secretary of Defense (Research and Engineering) ATTN: Technical Library Room 3E1065, The Pentagon Washington 25, D. C.	1
Chief of Research and Development Department of the Army Washington 25, D. C.	2
Chief, United States Army Security Agency ATTN: ACofS, G4 (Technical Library) Arlington Hall Station Arlington 12, Virginia	1
Commanding Officer U. S. Army Electronics Research and Development Activity ATTN: Technical Library Fort Huachuca, Arizona	1
Commanding Officer U. S. Army Electronics Research and Development Activity ATTN: SELWS-AJ White Sands, New Mexico	1
Commanding Officer U. S. Army Electronics Research Unit P. O. Box 205 Mountain View, California	1
Commanding Officer U. S. Army Electronics Materiel Support Agency ATTN: SELMS-ADJ Fort Monmouth, New Jersey	1

	Copies
Commanding General U. S. Army Satellite Communications Agency ATTN: Technical Documents Center Fort Monmouth, New Jersey	1
Director U. S. Army Engineer Research and Development Laboratories ATTN: Technical Documents Center Fort Belvoir, Virginia	1
Commanding Officer U. S. Army Chemical Warfare Laboratories ATTN: Technical Library, Building 330 Army Chemical Center, Maryland	1
Commanding Officer Harry Diamond Laboratories ATTN: Library, Building 92, Room 211 Washington 25, D. C.	1
Headquarters, United States Air Force ATTN: AFCIN Washington 25, D. C.	2
Rome Air Development Center ATTN: RAALD Griffiss Air Force Base New York	1
Headquarters Ground Electronics Engineering Installation Agency ATTN: ROZMEL Griffiss Air Force Base New York	1
Commanding General U. S. Army Materiel Command ATTN: R&D Directorate Washington 25, D. C.	2

	Copies
Aeronautical Systems Division ATTN: ASAPRL Wright-Patterson Air Force Base Ohio	1
U. S. Air Force Security Service ATTN: ESD San Antonio, Texas	1
Headquarters Strategic Air Command ATTN: DOCE Offutt Air Force Base, Nebraska	1
Headquarters Research & Technology Division ATTN: RTH Bolling Air Force Base Washington 25, D. C.	1
Air Proving Ground Center ATTN: PGAPI Eglin Air Force Base, Florida	1
Air Force Cambridge Research Laboratories ATTN: CRXL-R L. G. Hanscom Field Bedford, Massachusetts	2
Headquarters Electronic Systems Division ATTN: ESAT L. G. Hanscom Field Bedford, Massachusetts	2
AFSC Scientific/Technical Liaison Office U. S. Naval Air Development Center Johnsville, Pa.	1
Chief of Naval Research ATTN: Code 427 Department of the Navy Washington 25, D. C.	1
Bureau of Ships Technical Library ATTN: Code 312 Main Navy Building, Room 1528 Washington 25, D. C.	1

	Copies
Chief, Bureau of Ships ATTN: Code 454 Department of the Navy Washington 25, D. C.	1
Chief, Bureau of Ships ATTN: Code 686B Department of the Navy Washington 25, D. C.	1
Director U. S. Naval Research Laboratory ATTN: Code 2027 Washington 25, D. C.	1
Commanding Officer & Director U. S. Navy Electronics Laboratory ATTN: Library San Diego 52, California	1
Commander U. S. Naval Ordnance Laboratory White Oak Silver Spring 19, Maryland	1
Commander Armed Services Technical Information Agency ATTN: TISIA Arlington Hall Station Arlington 12, Virginia	20
USAELRDL Liaison Officer U. S. Army Tank-Automotive Center Detroit Arsenal Center Line, Michigan	1
USAELRDL Liaison Officer Naval Research Laboratory ATTN: Code 1071 Washington 25, D. C.	1
USAELRDL Liaison Officer Massachusetts Institute of Technology Building 26, Room 131 77 Massachusetts Avenue Cambridge 39, Massachusetts	1

Distribution List (Cont)

	Copies
USAELRDL Liaison Office Aeronautical Systems Division ATTN: ASDL-9 Wright-Patterson Air Force Base Ohio	1
U. S. Army Research Liaison Office Lincoln Laboratory P. O. Box 73 Lexington, Massachusetts	1
USAELRDL Liaison Officer Rome Air Development Center ATTN: RAOL Griffiss Air Force Base New York	1
Commanding Officer U. S. Army Security Agency Processing Center Deal Area, Bldg. 5001	1
File Unit Nr. 1, Rm. 3D-116 Hexagon	1
USAEMSA Liaison Engineer USASCAJ APO 343 San Francisco, California	1
Technical Dir., SELRA/CS Headquarters, USAELRDL	1
USAELRDA-White Sands Liaison Office SELRA/LNW, USAELRDL	1
AFSC Scientific/Technical Liaison Office SELRA/LNA, USAELRDL	1
Corps of Engineers Liaison Office SELRA/LNE, USAELRDL	1
Marine Corps Liaison Office SELRA/LNR, USAELRDL	1
USACDC Liaison Office SELRA/LNF, USAELRDL	2

	Copies
Chief, Technical Information Division Headquarters, USAELRDL	6
USAELRDL Technical Documents Center SELRA/ADT, Hexagon	1
USAELRDL Liaison Officer U. S. Army Combat Development Command, CDCLN-EL Fort Belvoir, Virginia	1
Director, Electronic Components Dept., SELRA/P	1
Director, Electronic Parts and Materials Div., SELRA/PE	1
Chief, Reliability and Electronic Parts Branch, SELRA/PEE	80
Chief, Defense Atomic Support Agency, Attn: Document Library Branch, Washington 25, D. C.	1

Army, Ft. Monmouth, NJ-MON 233-63

AD ______________ Div. ______________

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS (SPRF #1), by W. Schlosser, C. P. Lascaro, J. Key, September 1962, 45 p. incl. illus. tables, 5 refs. (USAELRDL Technical Report 2306) (DA Task 3A99-15-006-01)

Unclassified Report

The results of a recent series of experiments conducted on electronic parts at the Sandia Pulsed Reactor Facility (SPRF) are discussed. Cables, resistors, and ferrite cores were included in the program. The measurements on cables bear out the fact that reliable data for component parts cannot be obtained for many component parts because of the unpredictable behavior of the cables used for signal transmission.

UNCLASSIFIED

1. Transient Effects--Pulsed Nuclear Radiation
2. Electronic Parts & Materials--Transient Effects of Pulsed Radiation

I. Schlosser, W.
Lascaro, C. P.
Key, J.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-006-01

UNCLASSIFIED

AD ______________ Div. ______________

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS (SPRF #1), by W. Schlosser, C. P. Lascaro, J. Key, September 1962, 45 p. incl. illus. tables, 5 refs. (USAELRDL Technical Report 2306) (DA Task 3A99-15-006-01)

Unclassified Report

The results of a recent series of experiments conducted on electronic parts at the Sandia Pulsed Reactor Facility (SPRF) are discussed. Cables, resistors, and ferrite cores were included in the program. The measurements on cables bear out the fact that reliable data for component parts cannot be obtained for many component parts because of the unpredictable behavior of the cables used for signal transmission.

UNCLASSIFIED

1. Transient Effects--Pulsed Nuclear Radiation
2. Electronic Parts & Materials--Transient Effects of Pulsed Radiation

I. Schlosser, W.
Lascaro, C. P.
Key, J.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-006-01

UNCLASSIFIED

AD ______________ Div. ______________

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS (SPRF #1), by W. Schlosser, C. P. Lascaro, J. Key, September 1962, 45 p. incl. illus. tables, 5 refs. (USAELRDL Technical Report 2306) (DA Task 3A99-15-006-01)

Unclassified Report

The results of a recent series of experiments conducted on electronic parts at the Sandia Pulsed Reactor Facility (SPRF) are discussed. Cables, resistors, and ferrite cores were included in the program. The measurements on cables bear out the fact that reliable data for component parts cannot be obtained for many component parts because of the unpredictable behavior of the cables used for signal transmission.

UNCLASSIFIED

1. Transient Effects--Pulsed Nuclear Radiation
2. Electronic Parts & Materials--Transient Effects of Pulsed Radiation

I. Schlosser, W.
Lascaro, C. P.
Key, J.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-006-01

UNCLASSIFIED

AD ______________ Div. ______________

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS (SPRF #1), by W. Schlosser, C. P. Lascaro, J. Key, September 1962, 45 p. incl. illus. tables, 5 refs. (USAELRDL Technical Report 2306) (DA Task 3A99-15-006-01)

Unclassified Report

The results of a recent series of experiments conducted on electronic parts at the Sandia Pulsed Reactor Facility (SPRF) are discussed. Cables, resistors, and ferrite cores were included in the program. The measurements on cables bear out the fact that reliable data for component parts cannot be obtained for many component parts because of the unpredictable behavior of the cables used for signal transmission.

UNCLASSIFIED

1. Transient Effects--Pulsed Nuclear Radiation
2. Electronic Parts & Materials--Transient Effects of Pulsed Radiation

I. Schlosser, W.
Lascaro, C. P.
Key, J.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-006-01

UNCLASSIFIED